SUPPLEMENTAL
GEOTECHNICAL INVESTIGATION
SR-167 HOV LANES, STAGE I
KING COUNTY, WASHINGTON

HWA Project No. 91101-2

May 21, 1993

Prepared For

Washington State Department of Transportation
District 1
c/o Alpha Engineering Group, Inc.

HONG WEST
& ASSOCIATES, INC.

HONG WEST
& ASSOCIATES, INC.

Geotechnical Engineering
Hydrogeology
Geoenvironmental Services
Testing & Inspection

May 21, 1993
HWA Project No. 91101-2

WSDOT District 1
c/o Alpha Engineering Group, Inc.
16040 Christensen Road
Seattle, Washington 98188

Attention: Mr. Tom Murawski

Subject: **SUPPLEMENTAL GEOTECHNICAL INVESTIGATION**
SR-167 HOV Lanes, Stage I
King County, Washington

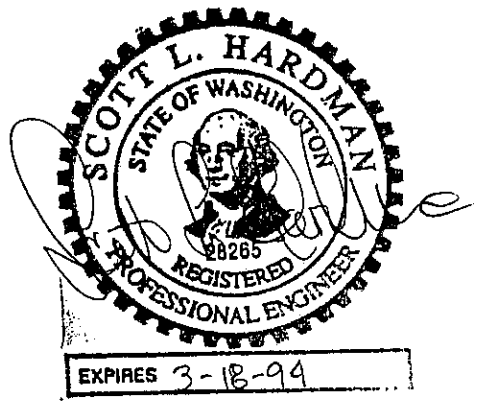
Dear Mr. Murawski:

In accordance with your request, Hong West & Associates, Inc. (HWA) has completed a supplemental geotechnical investigation for the above referenced project. Results of our investigation are presented in the accompanying report.

The opportunity of providing geotechnical services on this project is appreciated. Should you have any questions, or if we may be of further service, please do not hesitate to call.

Sincerely,

HONG WEST & ASSOCIATES, INC.



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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Stage I of the SR-167 HOV Lanes project extends from the 84th Ave. S. Interchange north to the Interstate 405 Interchange. The project entails constructing HOV lanes in the existing median area, ramp improvements and associated retaining and drainage structures. Geotechnical investigation in support of Design Report preparation was previously provided by HWA. Since that time, certain proposed improvements, notably Wall 6 through Wall 9, have been addressed at PS&E level by others. The scope of work that is addressed in this report is summarized in Section 1.3, below.

1.2 AUTHORIZATION

Authorization to proceed with the proposed work was received in a Supplemental Agreement between Alpha Engineering Group, Inc. and HWA, dated March 16, 1993.

1.3 SCOPE OF WORK

A proposal for the supplemental geotechnical investigation was submitted on February 15, 1993, and was subsequently revised on February 17, 1993. The scope of this investigation includes providing geotechnical data in support of PS&E preparation for selected drainage structures, ramp improvements, and median wall as outlined below:

- Fill settlement and the potential impacts on the existing buildings along DR1 Ramp, 84th Ave. S. Interchange.
- Drainage structures along DR1 Ramp, 84th Ave. S. Interchange.
- Two proposed culvert crossings that will be constructed by jacking beneath the highway.
- Settlement evaluation of median barrier walls greater than approximately 3 feet in height, and underlain by soft, compressible soils identified during previous studies.

Details of our proposed geotechnical investigation are included in the previously referenced proposal, and are summarized below:

- Data collection and review.
- Subsurface exploration at selected locations.
- Laboratory testing on selected soil samples.
- Engineering analyses pertinent to design and construction of the proposed structures.
- Report preparation, review, and revision.
- Project management and meeting participation.

This study is limited to the evaluation of the physical soil parameters only; the evaluation of chemical properties of soil or groundwater, or the presence of hazardous materials on site, are beyond the proposed scope of work.

2.0 SITE CONDITIONS

2.1 GENERAL GEOLOGY

The project alignment is located in the Green River Valley, South King County, Washington. The valley is approximately one mile wide, and is flanked by hillsides on the east and west. Geologic units underlying the valley floor, where SR-167 is located, consist primarily of post-glacial sand and silt deposits. These alluvial sediments are a result of Holocene drainage of the flanking higher land, or were deposited during the seasonal flooding of the Green, Cedar and White Rivers. Organic soils and peat deposits, which represent former bogs and lakes of the flat-bottomed river valley, are also found in isolated areas along the alignment.

2.2 STRATIGRAPHY

2.2.1 DR1 Ramp, 84th Ave. S. Interchange

Three borings (B-1 through B-3) were drilled at locations indicated on Figure 2 during the present subsurface exploration program. A test pit (TP-29) was excavated in the vicinity during the prior design report level study. The test pit location is also indicated on Figure 2.

The borings and test pit were conducted near the toe of the existing embankment. Soil conditions encountered generally consisted of interbedded soft silt/clay, loose fine sand and soft peat. The measured SPT N-values generally ranged from 1 to 4 blows per foot (bpf) in silt and clay, and 3 to 18 bpf in fine sand. In borings B-2 and B-3, located at Sta. DR1 896+90 and Sta. DR1 895+00, respectively, soft soil and peat extends to a depth of approximately 15 feet below the existing ground surface, and is underlain by silty fine sand and sandy silt. In test pit TP-29, which was excavated

approximately 50 feet south of B-3, soft soil and peat were encountered to the depth of exploration at 13 feet. Soft soil and peat appear to thin toward the south. Near the south end of the DR1 Ramp where B-1 was drilled at Sta. DR1 893+70, soft soil was encountered only in the uppermost 5 feet of the boring, and in turn was underlain by silty fine sand.

Groundwater was encountered in all borings and the test pit during the field exploration. In B-1, B-3 and TP-29, groundwater was observed at a depth of approximately 5 feet below the existing ground surface. In B-2, based on observation of sampling rods, groundwater was encountered at 17 feet below ground surface. However, it appears improbable that such a high hydraulic gradient would exist at the site. It is therefore assumed that the groundwater table is 5 feet below the existing ground surface along the DR1 Ramp, for design and analytical purposes.

2.2.2 Culvert Crossing at Station L 909

Two exploratory borings, B-8 and B-9, were drilled at this location to depths of 15 and 20 feet, respectively. Approximate boring locations are indicated on Figure 3. Subsurface conditions encountered in the borings were fairly consistent. Both borings encountered 7 to 8 feet of fill material consisting of very loose, brown, silty fine sand and fine sandy silt. Recorded SPT N-values were 2 and 4 bpf. Below the fill materials, grey silt and sandy silt with recorded SPT N-values of 4 and 10 bpf were observed to depths of approximately 12 feet. The lowermost soil unit encountered consisted of interbedded silt and silty fine sand in B-8 to very silty fine sand in B-9. Recorded SPT N-values ranged from 7 bpf in B-8 to 10 and 23 bpf in B-9. In B-8, the boring was terminated at a depth of 15 feet due to refusal of drilling equipment; the boring probably intercepted wood.

Groundwater was encountered at a depth of approximately 10 feet in B-8, which is approximately the free water surface in the drainage ditch at the toe of the embankment. Groundwater elevation was not determined in B-9 because water was added into the boreholes to minimize heaving. However, since the drainage ditches at both sides of the highway are interconnected with an existing culvert, it may be reasonable to assume similar groundwater conditions in both borings.

2.2.3 Culvert Crossing at Station L 1120+70

Borings B-10 and B-11 were drilled to depths of 26 and 18 feet, respectively, at the approximate locations indicated on Figure 4. Boring B-10, which was drilled from the top of an embankment, intercepted approximately 12 feet of fill material, 5 feet of peat, and 7 feet of very soft clay underlain by silty fine sand. The fill material predominantly consisted of silt and sandy silt with SPT N-values of 6 and 14 bpf.

Penetration resistance in the peat and clay strata was significantly lower; SPT N-values of 5 and 2 bpf were measured. The underlying silty fine sand is very loose; a SPT N-value of 9 bpf was recorded in the layer.

Boring B-11 was drilled at the toe of the freeway embankment in a swampy area. Due to access constraints, the boring was drilled with a light-weight, portable drill rig. The upper 8 feet of soil consisted of very soft silt and peat with SPT N-value of 2 bpf. Below the peat layer, very loose silty fine sand and fine sandy silt were encountered, with recorded SPT N-values ranging from 5 to12 bpf and averaging about 8 bpf.

2.2.4 Sta. L 912+50 to Sta. L 919+20, Median Area

Borings B-4 and B-5 were drilled within this section at Sta. 913+00 and Sta. 918+00, respectively. The approximate boring locations are shown on Figure 5. Both borings were drilled to depths of 16 feet. Boring B-4 intercepted approximately 2 feet of sandy gravel, which is interpreted as road fill, underlain by sandy silt to a depth of 12 feet. Recorded SPT N-values in the silt layer were in the range of 4 to 12 bpf, averaging about 6 bpf. Below the silt, a unit of grey, silty fine sand was encountered to the depth of exploration. An SPT N-value of 23 bpf was measured in this layer.

In boring B-5, the uppermost 2 feet consisted of fill materials, predominantly gravelly, sandy silt, in turn underlain by peat and soft organic soil to a depth of approximately 10 feet. SPT N-values of 7 and 1 bpf were recorded in the peat and organic soil layers, respectively. The lowermost unit encountered consisted of interbedded very silty fine sand and fine sandy silt, extending from 10 feet to the bottom of the boring. Recorded SPT N-values were 18 and 4 bpf.

Groundwater was encountered in both borings at depths of approximately 8.5 to 9 feet below the existing ground surface.

2.2.5 Sta. L 1000+50 to Sta. L 1005+50, Median Area

Borings B-6 and B-7 were drilled at Sta. L 1001+00 and Sta. 1004+55, respectively, to depths of approximately 16 feet. Approximate locations of these borings are indicated on Figure 6. Stratigraphy encountered in both borings was similar; consisting of road fill over soft organic soil and peat, over silt and fine sand. The fill material consisted of approximately 4 feet of silty sand in B-6, and approximately 2 feet of gravelly, silty sand in B-7. An SPT N-Value of 10 bpf was recorded in the fill material. The underlying soft peat and organic soil extended to depths of 8 and 11 feet in B-6 and B-7, respectively. Below this layer, sandy silt and silty sand extended to the bottoms of the borings. SPT N-values measured in the silt/sand layer were between 4 and 18 bpf.

Groundwater was encountered at depths of 15 and 10 feet in B-6 and B-7, respectively.

2.3 RESULTS OF PEAT PROBING

Probing of soft soils was conducted at the following locations:

- 84th Ave. S. Interchange, DR1 Ramp, Sta. DR1 896+00 to Sta. L 904+00
- S. 212th Street Interchange, E-WS Ramp, Sta. EW-S 41+30 to Sta. EW-S 45+70
- S. 180th St. Interchange, DR2 Ramp, Sta. 1075+00 to Sta. 1082+00

The purpose of the probing was to assess the thickness of soft compressible soil beneath specific proposed embankment fill areas. The results of the probings are shown on Figures 2, 3, 7, and 8.

It should be noted that peat probing is an imprecise method; it was conducted by manually forcing a steel rod into the ground. However, the probing does provide a relative estimate of thickness of soft soils.

Peat probing near S. 180th St. Interchange was conducted in the area where Wall No. 7 is proposed (see Figure 8). Detailed geotechnical investigation for Wall No. 7 was conducted by Shannon and Wilson in 1993. The recommendations provided by Shannon and Wilson should be incorporated in design and construction; the probe depths herein may provide supplemental information, but should not take precedence over recommendations made by Shannon and Wilson relative to Wall No. 7.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations for the 84th Ave. S. Interchange, DR1 Ramp improvements, including settlement potential, impacts on existing buildings and drainage structures are presented below. In addition, the culvert crossings and portions of the median barrier walls included in this study are addressed.

Previous geotechnical investigation reports relevant to the project are referenced in Section 5.0. The conclusions and recommendations of those reports remain applicable unless specifically superseded herein.

Our understanding of the proposed SR-167 improvements is based on project plans prepared by WSDOT. Should the planned improvements differ from those assumed

herein, HWA should be notified for review and revision of our conclusions and recommendations, if necessary.

3.1 84TH AVE. S. INTERCHANGE, DR1 RAMP

Based on cross-sectional drawings provided by WSDOT, the proposed ramp improvements include a 10-foot widening of the existing embankment to the east, and installation of a drainage pipe near the toe of the existing embankment. Two existing single story masonry/concrete buildings are located near the WSDOT right-of-way, and the potential impacts of ground settlement on the existing buildings had been briefly discussed in the previous HWA geotechnical investigation report. In light of the additional subsurface and design information, the settlement potential was evaluated in more detail.

Considerations for general earthwork including subgrade preparation, selection of fill material and compaction criteria for the ramp improvements were discussed in HWA's design level soils report, dated March 18, 1992. The reader may refer to the March 18 report for details.

3.1.1 Settlement Potential

Settlement potential was evaluated at three locations along the DR1 Ramp, Cross Sections A-A', B-B' and C-C', Figures 9 through 11, respectively. By inspection, Sections B-B' and C-C' are more critical because of closer proximity of new fill to the existing building, as well as greater thickness of additional fill material and peat/organic soil.

At Section C-C', the new fill will be approximately 5 feet high and approximately 10 feet away from an existing building. The increase in stresses due to the additional fill material was calculated using the Boussinesq equation, and the resulting settlements were estimated using the theory of one-dimensional consolidation. A maximum settlement of approximately 5 inches is estimated near the toe of the existing embankment. Estimated settlement decreases away from the existing embankment toe.

At Section B-B', thick organic deposits were encountered in B-3. With an additional 4 feet of new fill material, maximum settlement on the order of 6 inches was estimated.

Primary consolidation is a gradual process of pore water pressure dissipation. Along DR1 Ramp, it is estimated that a maximum of 4 months will be required for essential completion of primary consolidation. Based on the soil conditions encountered in borings, it is anticipated that a shorter time will be required toward the south of the

DR1 Ramp. A 3-month preloading period is recommended to reduce the potential of post-construction settlement.

3.1.2 Impacts on Existing Buildings

Based on the results of the settlement analysis discussed above, some consolidation will occur beneath the existing buildings as a result of the planned DR1 Ramp embankment fill. Two existing buildings may be impacted by placement of additional fill. These buildings are shown on Figure 2. Information regarding the foundation types of the existing buildings is not readily available. Based on conversation with a building owner, it is our understanding that the existing buildings are supported on spread footings.

The maximum amount of settlement is expected to occur immediately below the northwest corner of the north building (Sta. DR1 897+00), primarily due to the close proximity of the new fill to the building. At this location, settlement of approximately 1/4 inch is estimated. Settlement is expected to decrease toward the south as the toe of the new fill is further away from the existing buildings. At Sta. DR1 895+00, which is located between the two buildings, settlement of 1/10 inch at the west building line is estimated. In our opinion, 1/4 inch differential settlement should not produce structural or significant cosmetic damage to the existing buildings.

Monitoring of settlements at the two building locations may be advisable during construction to verify the estimates presented herein and to protect against potential claims. A survey of structural conditions before and after construction may also be advisable.

3.1.3 Drainage Structures

Drainage Pipe

A 60-inch diameter drainage pipe is proposed between Sta. L 893+45 and Sta. L 902+00, and a 24-inch diameter pipe is planned between Sta. L 902 and Sta. L 903. The drainage pipes will be located near the toe of the existing embankment, or approximately 20 feet west of the existing buildings, with invert levels generally 2 to 4 feet below the existing grade. Approximate location of the drainage pipe, based on the drawings provided by WSDOT, is shown on Figures 9 through 11.

Based on the results of our settlement analysis, up to 5 inches of settlement may occur along the pipe alignment. From borings B-1 through B-3, soft fine-grained soil and peat extend to a depth of approximately 15 feet below existing grade. It is not practical to completely remove the soft compressible soil layer, because of the excessive depth.

However, to provide a level and uniform support surface for the pipes, it is recommended that the soft soil be overexcavated to a depth of 2 feet below the invert level, and replaced with properly compacted clean granular soil. Use of a geotextile is also recommended, as a separator between the native soft soil and the imported granular fill.

In our opinion, the drainage pipe should be installed approximately 3 months after the proposed embankment fill materials are placed. This will allow the majority of primary settlement to occur before placing the drainage pipe.

Temporary Excavations

Trenches for pipelines and catch basins may be excavated with conventional excavation equipment. Along the DR1 Ramp, excavation sidewalls greater than 4 feet deep should be properly supported to protect the embankment and to minimize the disturbance of soils adjacent to the buildings. It is our opinion that use of trench boxes should be adequate, assuming groundwater seepage into the trench will be slow enough that it can be controlled by sump pumps. Otherwise, use of interlocking steel sheetings may be warranted. These steel sheetings (if used) should be installed to a depth sufficient to reduce groundwater seepage into the trenches.

It is the contractor's responsibility to select an appropriate support system for the trench excavation, and to assure the safety of workers, equipment and the adjacent structures. All excavation should conform to applicable local, state and federal regulations.

3.1.4 Construction Monitoring

Monitoring of settlement is recommended during the preloading period. It is recommended that three settlement devices be placed near the toe of the existing embankment to monitor the amount of settlement at the following locations:

- Sta. DR1 895+00, approximately 45 feet right
- Sta. DR1 897+00, approximately 45 feet right
- Sta. L 902+00, approximately 100 feet right

In our opinion, settlement devices such as the Slope Indicator Company Liquid Settlement System will be adequate for this project. It is recommended that the settlement data be interpreted by an experienced geotechnical engineer.

In addition, optical survey targets should also be established on the existing buildings. These targets should be surveyed before commencing earthwork, and monitoring should continue through the preloading period.

3.2 CULVERTS CROSSING SR-167

Based on the Drainage Plan-Drainage Area Map prepared by Alpha, jacking under the freeway is anticipated at two locations to facilitate the installation of large diameter culvert pipes. The first location is near the south end of the project, where a proposed 42-inch diameter pipe will cross the highway at approximately Sta. L 909. The second location is near the north end of the project at approximately Sta. L 1120+70; two parallel 48-inch diameter pipes are planned at this location. Cross section drawings at these two culvert crossing locations are shown on Figures 12 and 13, respectively.

3.2.1 General

It is anticipated that temporary excavations near the toes of the existing embankments will be required for jacking pits. Temporary shoring structures are envisaged to minimize the displacements of the existing embankment resulting from temporary excavation. In addition, to minimize the disturbance of surrounding wet ground, it may be necessary to construct retaining structures along all four sides of jacking pit, forming an enclosed cell, or cofferdam.

Some dewatering will be required to maintain a dry working platform in the jacking pits. However, it should be noted that drawdown of the groundwater table may result in some settlement, especially near Sta. L 1120+70 where relatively thick silt and peat deposit were encountered. Therefore, it is recommended that "impermeable" retaining structures, such as a sheet pile wall, be used for this application. Groundwater in the jacking pits can then be drawn down with less impact on the groundwater elevations outside the jacking pits.

Settlement of the existing road fill may occur if soils around the culvert crossings are significantly disturbed during the boring process. Therefore, it is recommended that the contractor select and implement a drilling method that will minimize the soil disturbance.

3.2.2 Shoring Design Pressures For Jacking Pits

The design of temporary shoring systems is the responsibility of contractor. The contractor will determine the size and depth of jacking pits required for the jacking operation. All shoring and excavation operations should be in conformance with applicable local, state and federal regulatory requirements, and should ensure the safety of construction personnel and equipment.

Pressure diagrams at each of the proposed culvert crossing locations, were developed to aid in design of the shoring systems. These pressure diagrams are shown on Figures 14 and 15.

3.3 MEDIAN BARRIER WALL

As discussed in the previously referenced HWA proposal, this investigation focuses on walls that are greater than approximately 3 feet high in areas where compressible soils are anticipated at shallow depths. Based on the subsurface conditions identified during previous investigations and proposed retaining wall information provided by WSDOT, two portions of the median wall were addressed in this supplemental study:

- between Sta. L 912+50 and Sta. L 919+20
- between Sta. L 1000+50 and Sta. L 1005+50

Profile drawings along these two sections of highway are shown on Figures 16 and 17, respectively.

Potential settlements in the median area due to additional fill material are discussed in the previous HWA report (March 18, 1992) and addendum (December 10, 1992). Readers are referred to these documents for additional information.

Conclusions and recommendations pertinent to median wall footing design and construction within the two sections investigated are discussed below.

3.3.1 Settlement Potential

Within the two sections of the median wall included in this study, the amount of additional fill material will be on the order of 3 feet on the southbound lane, and approximately 1 foot on the northbound lane. With the 3-foot additional fill, a maximum of approximately 2 inches of settlement is estimated as a result of primary consolidation. The settlement is not anticipated to be uniform, and may be significantly less than 2 inches in the vicinity of Sta. L 913+00 due to the absence of soft organic soil and peat. Peat also exhibits long term time-dependent settlement characteristics; it is estimated that 0.1 to 0.2 inch of secondary settlement could occur per log cycle of time.

The need for preloading was discussed at a December 2, 1992 meeting. The current analyses, based on additional subsurface exploration and laboratory testing, verify the previous estimates of approximately 2 inches of primary settlement. In view of the relatively small amount of additional fill material proposed, and concomitant small

estimated settlements, it was felt that preloading and settlement monitoring will not be cost effective. HWA concurs with this conclusion.

This analysis is based to some extent on subsurface conditions and soil properties interpreted from logs of exploratory borings and laboratory tests. These borings are widely spaced and localized deposits of peat and/or soft silt/clay may exist between the available borings. As discussed in the previously referenced HWA report, it may be advisable to design the new travel lanes within the existing median area utilizing a shorter life, allowing for subsequent pavement overlays.

3.3.2 Wall Footings

It is recommended that at least 1 foot of properly compacted granular fill material be placed below wall footings. In areas where footings are near or below the existing grade, overexcavation will be required to accommodate the 1-foot layer of granular soil. In areas where the bottom of the footing is more than 1 foot above the existing grade, overexcavation will not be required. However, clearing of vegetation and topsoil, where present, is recommended before placing additional fill material.

4.0 LIMITATIONS

This supplemental geotechnical investigation was planned and conducted in accordance with generally accepted engineering standards practiced presently within this geographic area. The analyses and recommendations contained in this report are made on the assumption that the soil conditions encountered in the borings are representative of actual conditions throughout the proposed alignment. However, experience has proven that subsoils can vary quite radically over small distances. Inconsistent conditions can occur between exploratory borings and not be detected during a geotechnical study. If, during construction, subsurface conditions are encountered which are different from those anticipated based on the results of this investigation, HWA should be notified so that we can review these variances and reconsider our recommendations wherever necessary.

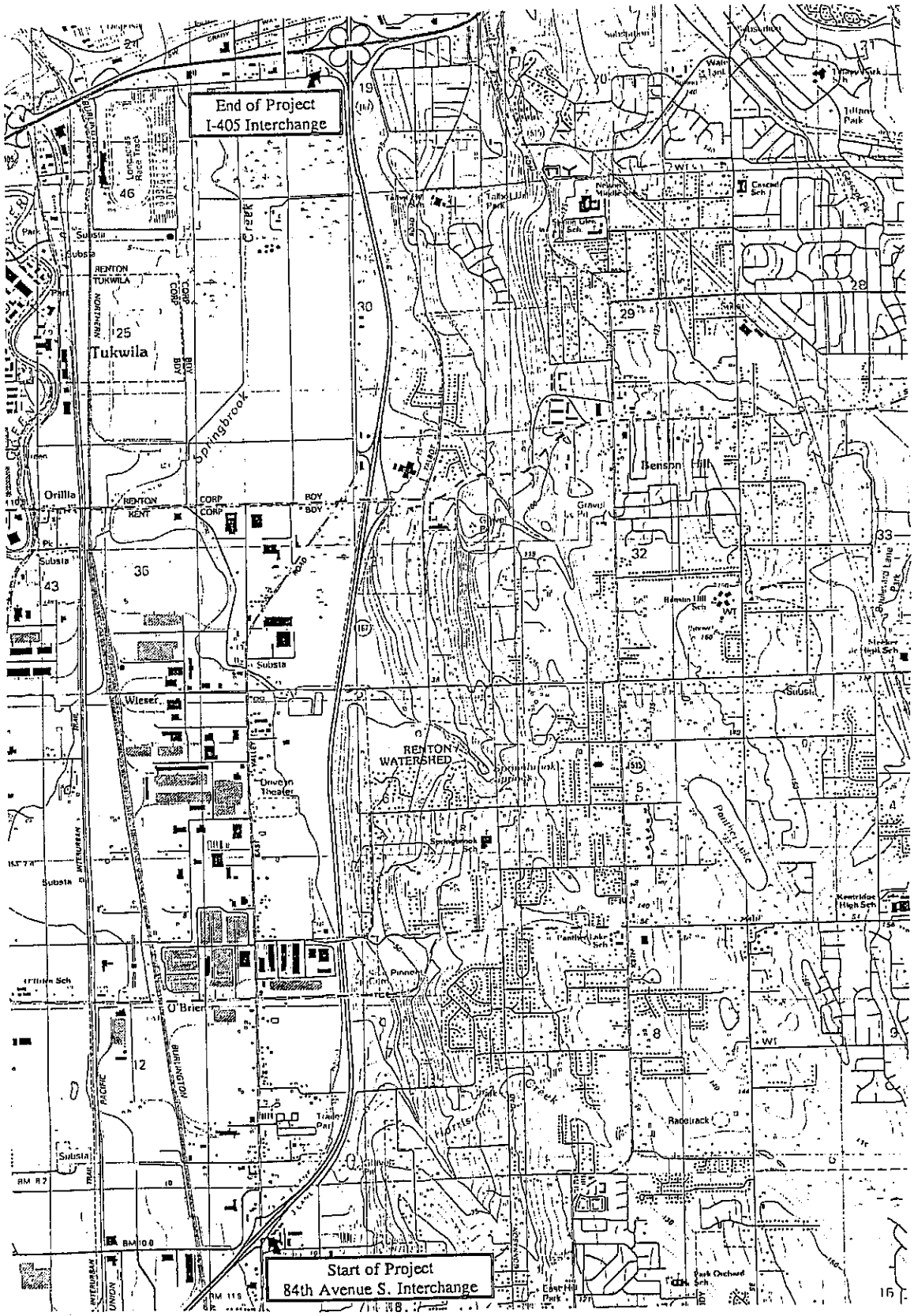
This report is prepared for the exclusive use of the owner and the owner's consultants for specific application on this project in accordance with generally accepted engineering practice. No warranty, expressed or implied, is made. In addition, geotechnical observation and testing is recommended during the construction phases to verify that the recommendations presented herein are incorporated in the project.

5.0 LIST OF REFERENCES

Hong West & Associates, Inc., *Geotechnical Investigation, SR-167, 15th Street S.W. To South Grady Way*, March 18, 1992.

Hong West & Associates, Inc., *Addendum to Geotechnical Investigation Report, SR-167, 15th Street S.W. To South Grady Way, South King County, Washington,* November 10, 1992, revised December 10, 1992.

Shannon & Wilson, Inc., Draft Geotechnical Report, *SR 167 HOV Lanes, Renton, Washington*, January, 1993.



BASE MAP REPRODUCED FROM 1983 USGS 1:25,000-SCALE METRIC TOPOGRAPHIC MAP OF RENTON, WASHINGTON

HONGWEST & ASSOCIATES, INC.

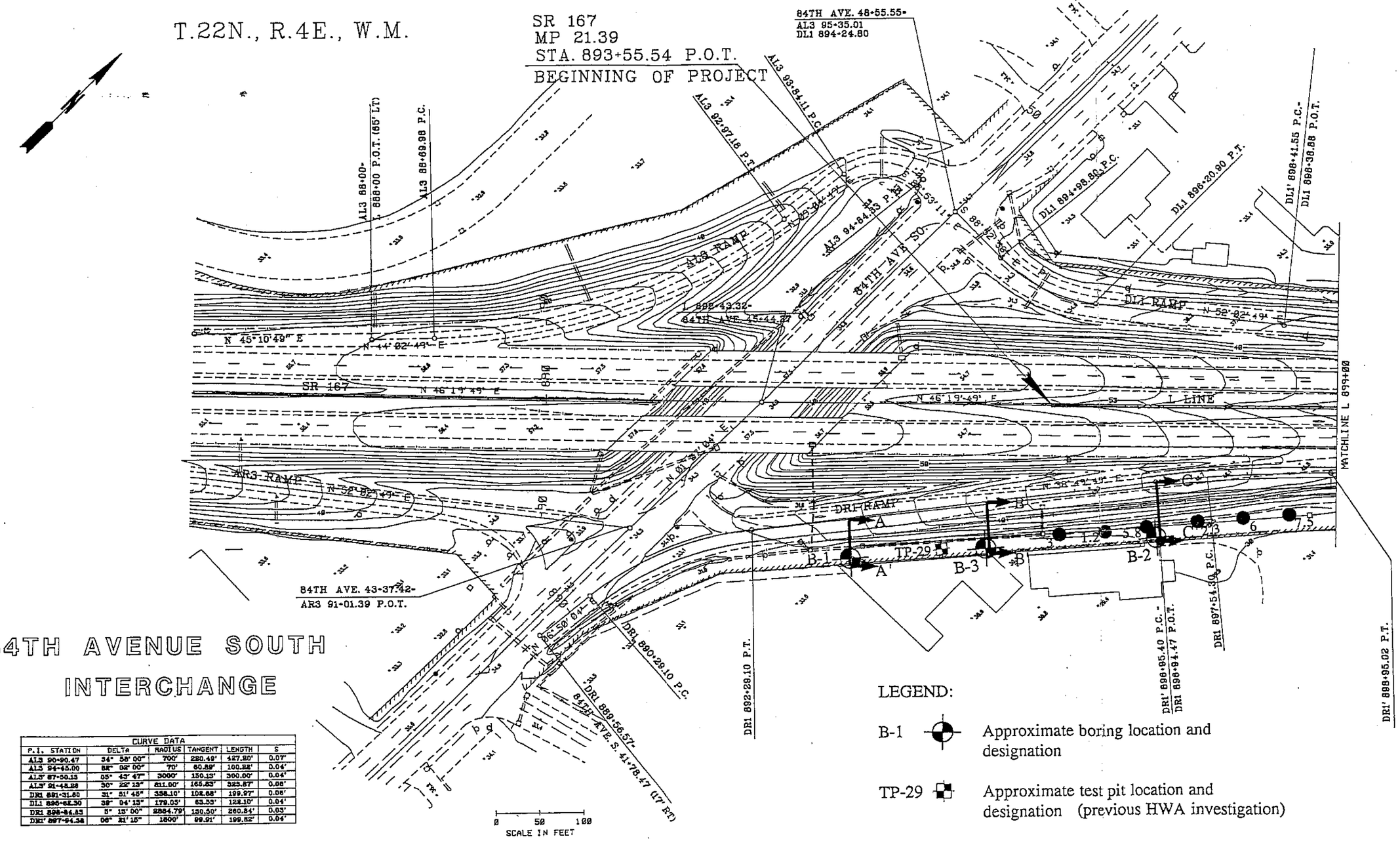
SR-167 HOV LANES

VICINITY MAP

PROJECT: 91101-2 FIGURE: 1

91101-A-002.0

T.22N., R.4E., W.M.



84TH AVENUE SOUTH INTERCHANGE

CURVE DATA					
P.I. STATION	DELTA	RADIUS	TANGENT	LENGTH	S
AL3 90+90.47	34° 58' 00"	700'	220.49'	427.80'	0.07'
AL3 94+45.00	58° 08' 00"	70'	60.89'	100.52'	0.04'
AL3' 87+50.15	05° 43' 47"	3000'	150.13'	300.00'	0.04'
AL3' 91+48.28	30° 22' 13"	811.00'	165.83'	323.87'	0.08'
DR1 891+31.80	31° 51' 45"	358.10'	102.68'	199.97'	0.08'
DL1 896+62.30	39° 04' 15"	179.05'	63.53'	122.10'	0.04'
DR1 898+84.83	5° 13' 00"	2884.79'	130.50'	260.84'	0.03'
DR1' 897+94.34	06° 21' 15"	1800'	99.91'	199.82'	0.04'

LEGEND:

B-1 — Approximate boring location and designation

TP-29 — Approximate test pit location and designation (previous HWA investigation)

5 ● — Approximate probe location and depth of penetration in feet

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

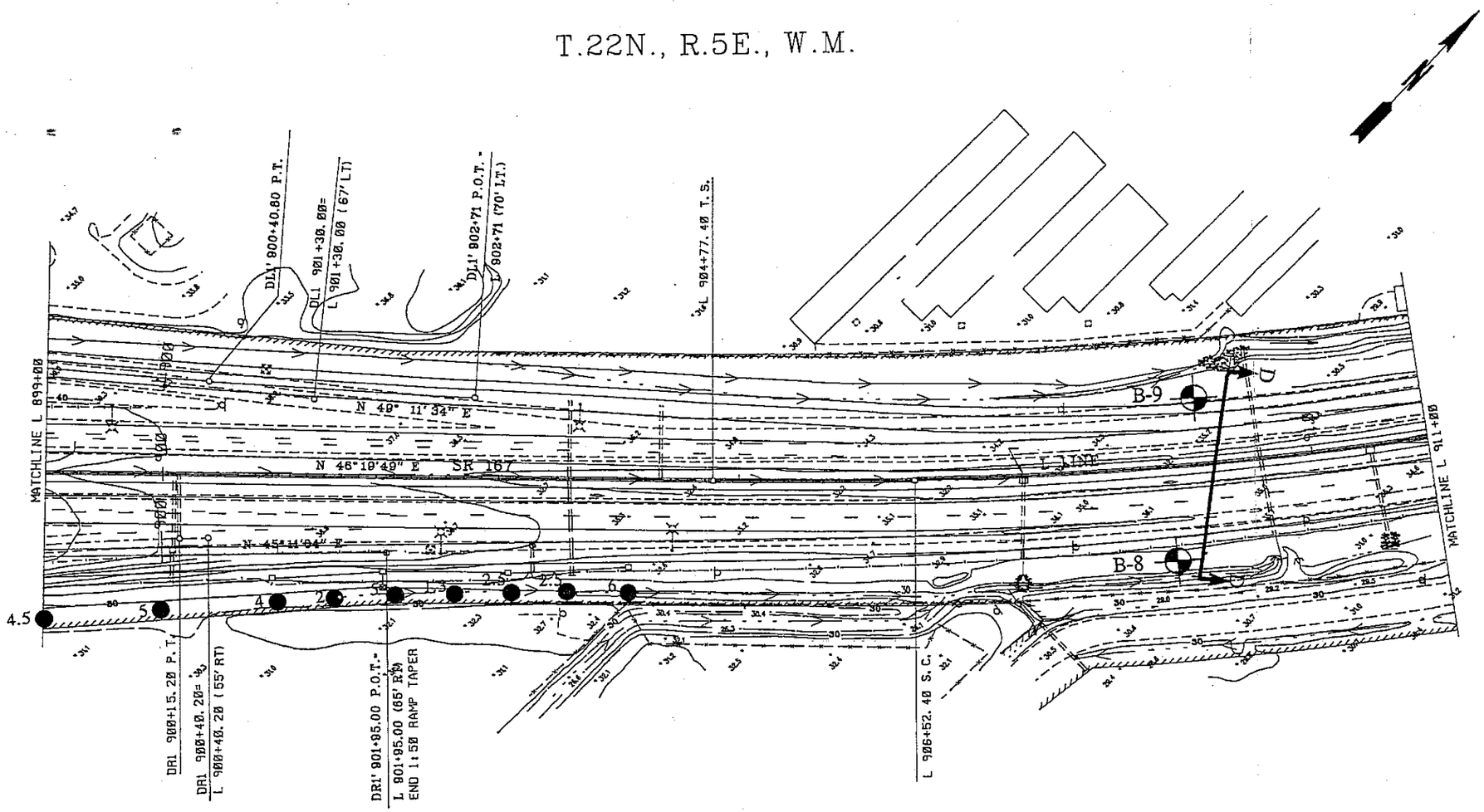
SR-167 HOV LANES

SITE & EXPLORATION PLAN
84th AVE. S. INTERCHANGE
DR1 RAMP

PROJECT: 91101-2 FIGURE: 2

91101-B-003.0

T.22N., R.5E., W.M.



CURVE DATA					
P.I. STATION	DELTA	RADIUS	TANGENT	LENGTH	S
DL1' 899+41.20	2° 51' 15"	4,000'	99.50'	199.28'	0.02'

LEGEND:

B-8 — Approximate boring location and designation

5 ● — Approximate probe location and depth of penetration in feet

0 50 100
SCALE IN FEET

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

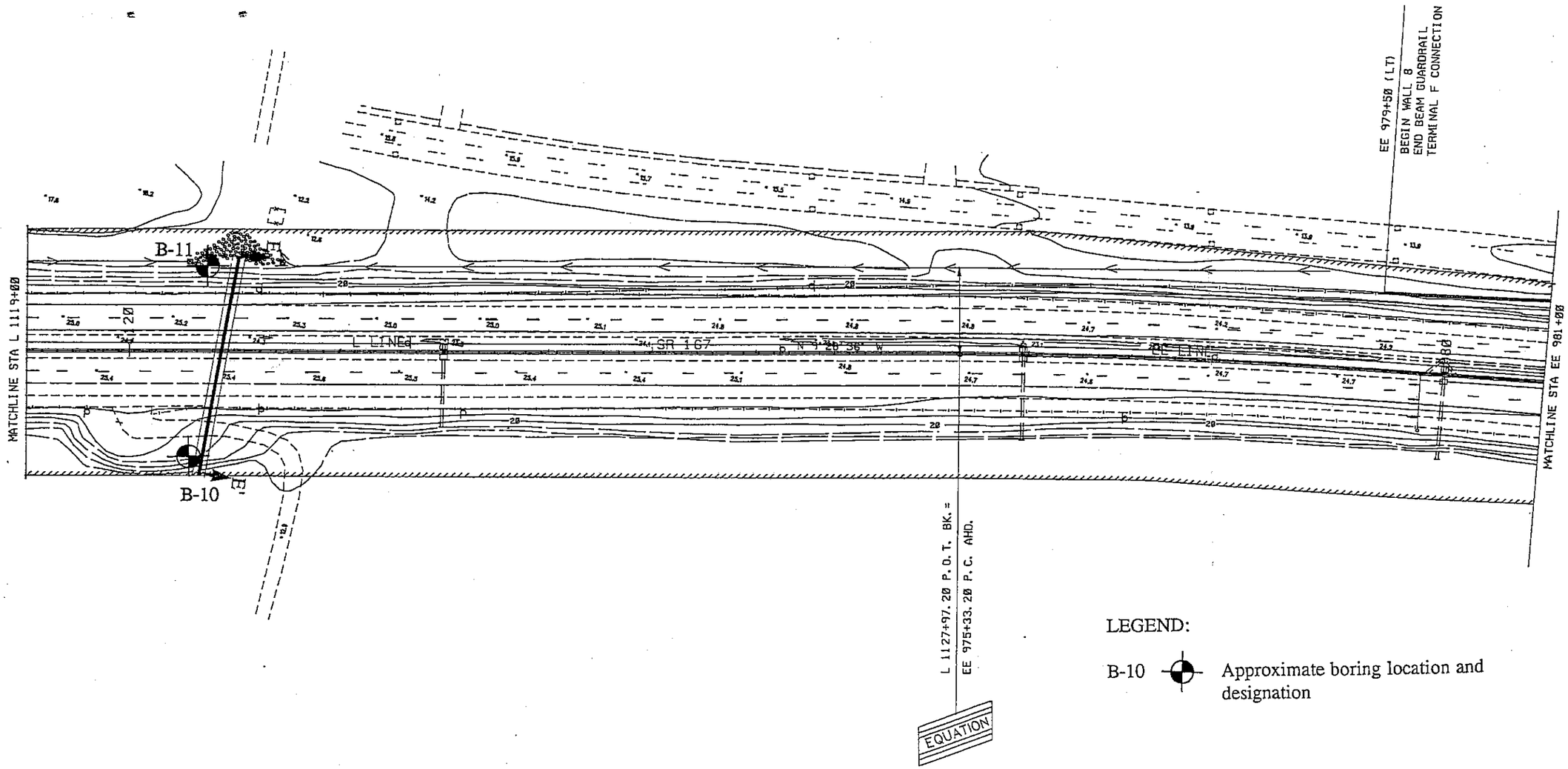
SR-167 HOV LANES

SITE & EXPLORATION PLAN
CULVERT CROSSING AT
STA. L 909

PROJECT: 91101-2 FIGURE: 3

91101-B-004.D

T.23N., R5E., W.M.



CURVE DATA					
P.I. STATION	DELTA	RADIUS	TANGENT	LENGTH	S
EE 980+84.90	11° 00' 00"	5729.60'	551.70'	1100.00'	0.03'

0 50 100
SCALE IN FEET

LEGEND:

B-10 ⊕ Approximate boring location and designation

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

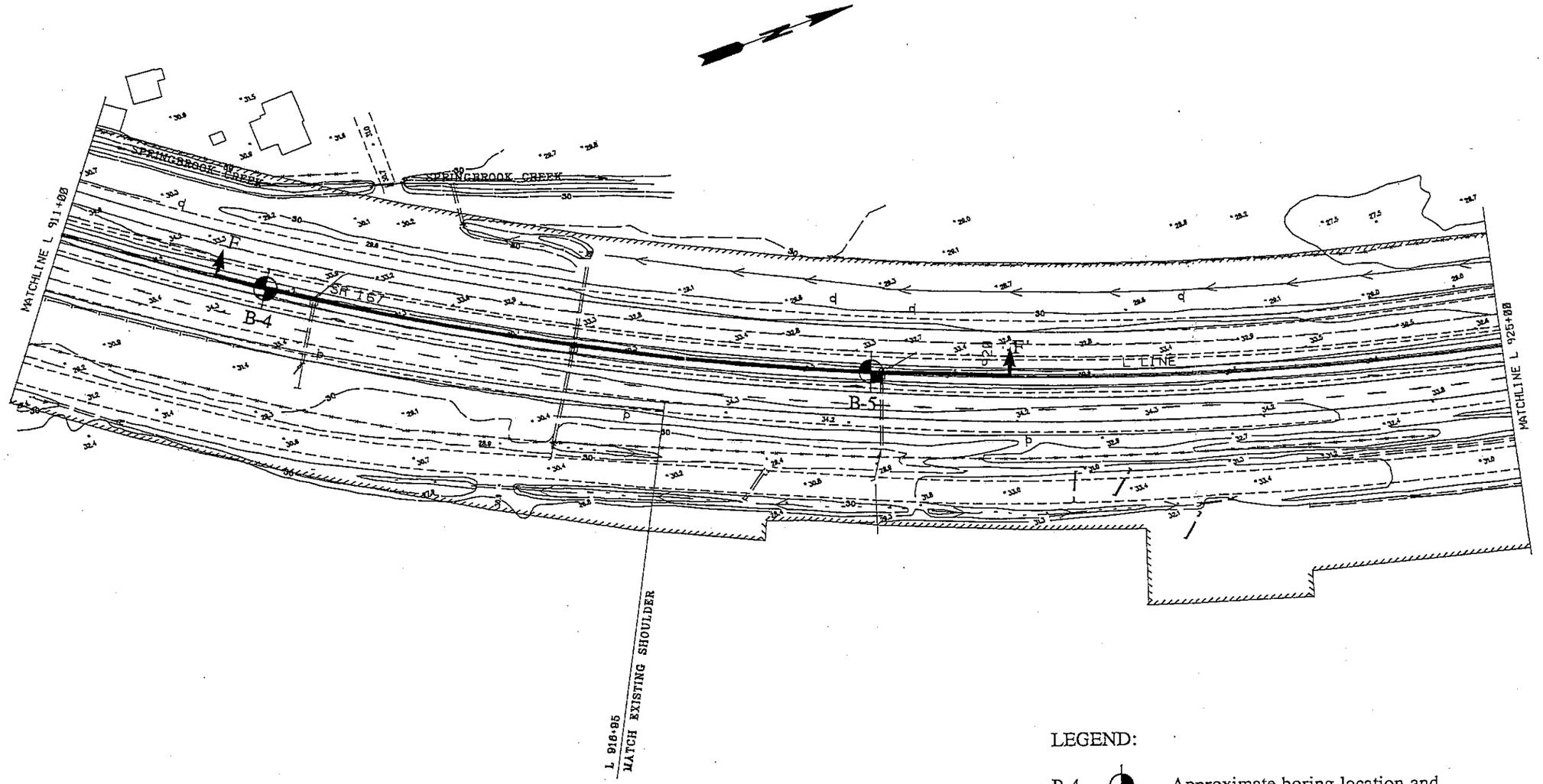
SR-167 HOV LANES

SITE & EXPLORATION PLAN
CULVERT CROSSING AT
STA. L 1120+70

PROJECT: 91101-2 FIGURE: 4

91101-B-005.0

T.22N., R.5E., W.M.



CURVE DATA								SPIRALS BACK & AHEAD		
P.I. STATION	DELTA	C DELTA	D	RADIUS	TANGENT	LENGTH	S	A	DE	LS
SR 167 920+17.8	47° 31' 00"	44° 47' 00"	1° 45'	3274.1'	1540.2'	2539.1'	-	1	1° 32'.	1.75

LEGEND:

B-4 ⊕ Approximate boring location and designation

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

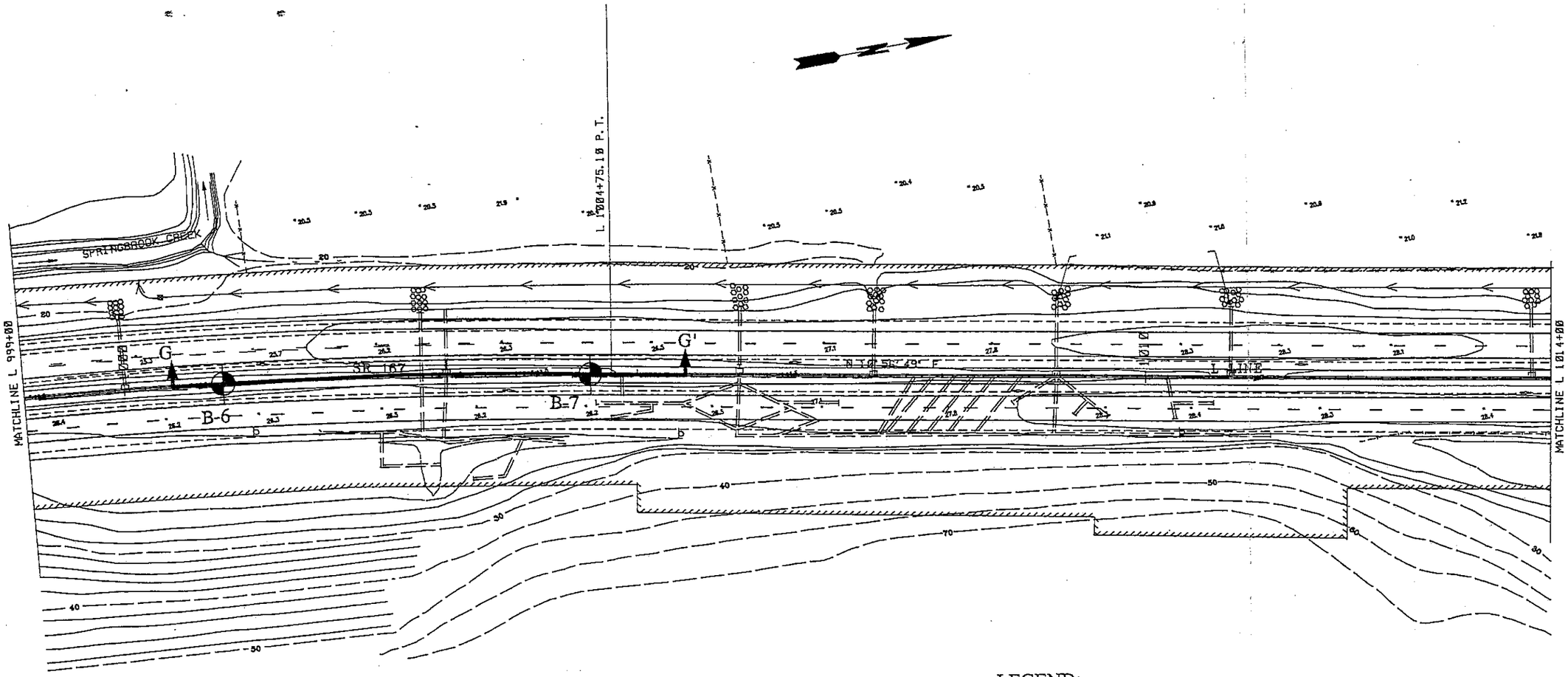
SR-167 HOV LANES

SITE & EXPLORATION PLAN
STA. L 912+50 TO
STA. L919+20

PROJECT: 91101-2 FIGURE: 5

91101-B-006.0

T.23N., R.5E., W.M.



LEGEND:

B-6 ⊕ Approximate boring location and designation

0 50 100
SCALE IN FEET

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

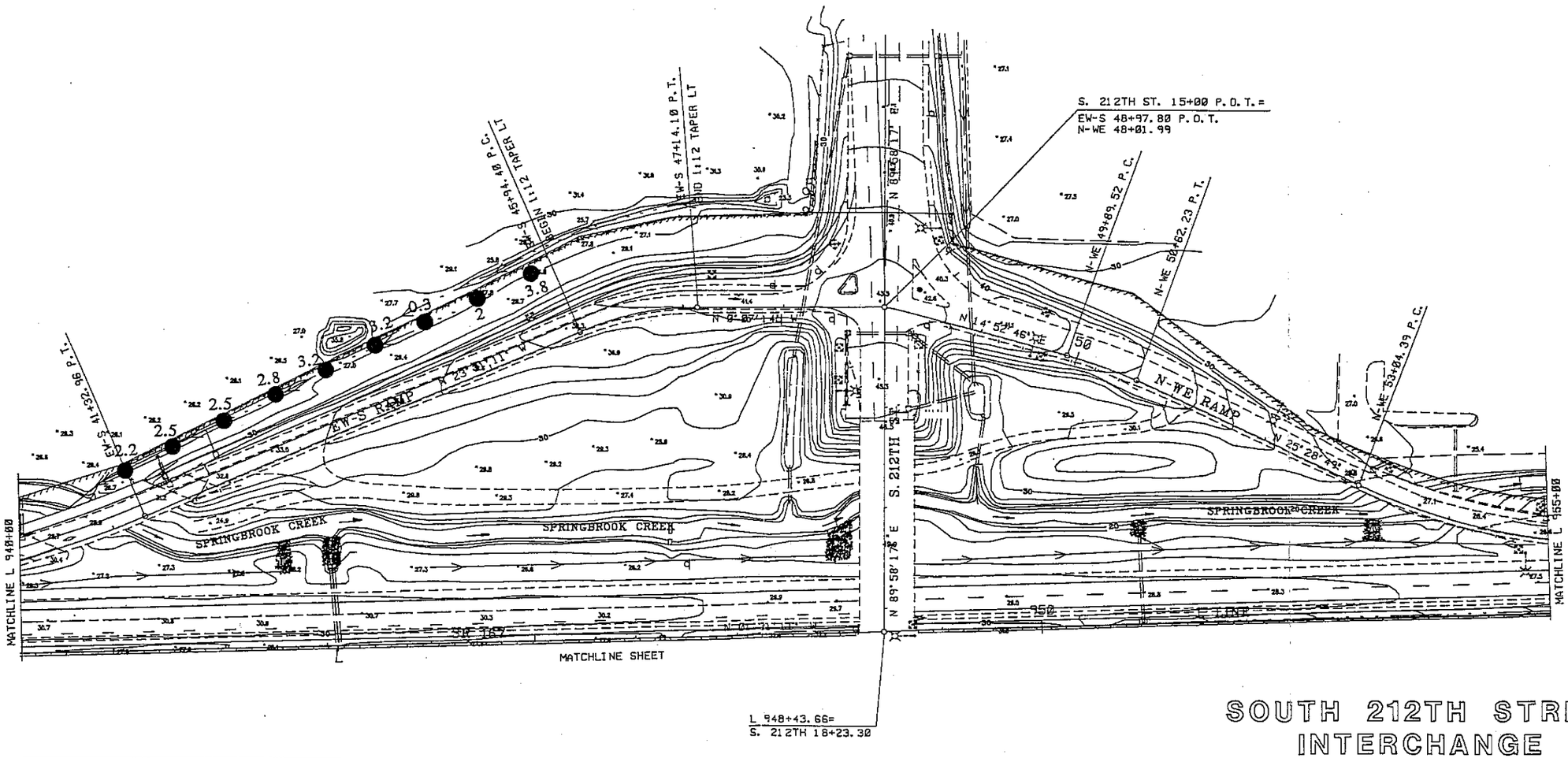
SR–167 HOV LANES

SITE & EXPLORATION PLAN
STA. L 1000+50 TO
STA. 1005+50

PROJECT: 91101–2 FIGURE: 6

91101–B–007.0

T.22N., R.5E., W.M.



CURVE DATA					
P.I. STATION	DELTA	RADIUS	TANGENT	LENGTH	S
EW-S 46+35.11	23° 23' 57"	293'	60.67'	119.56'	0.07'
EW-S 39+68.01	15° 36' 41"	1007'	168.01'	332.98'	0.08'
EW-S 37+50	1° 54' 19"	3007'	50.00'	100.00'	0.08'
N-WE 50+23.98	10° 36' 03"	593'	36.46'	72.71'	0.04'
N-WE 54+28.90	23° 11' 00"	607'	124.51'	245.61'	0.08'

0 50 100
SCALE IN FEET

LEGEND:

2● Approximate probe location and depth of penetration in feet

SOUTH 212TH STREET INTERCHANGE

Base map prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

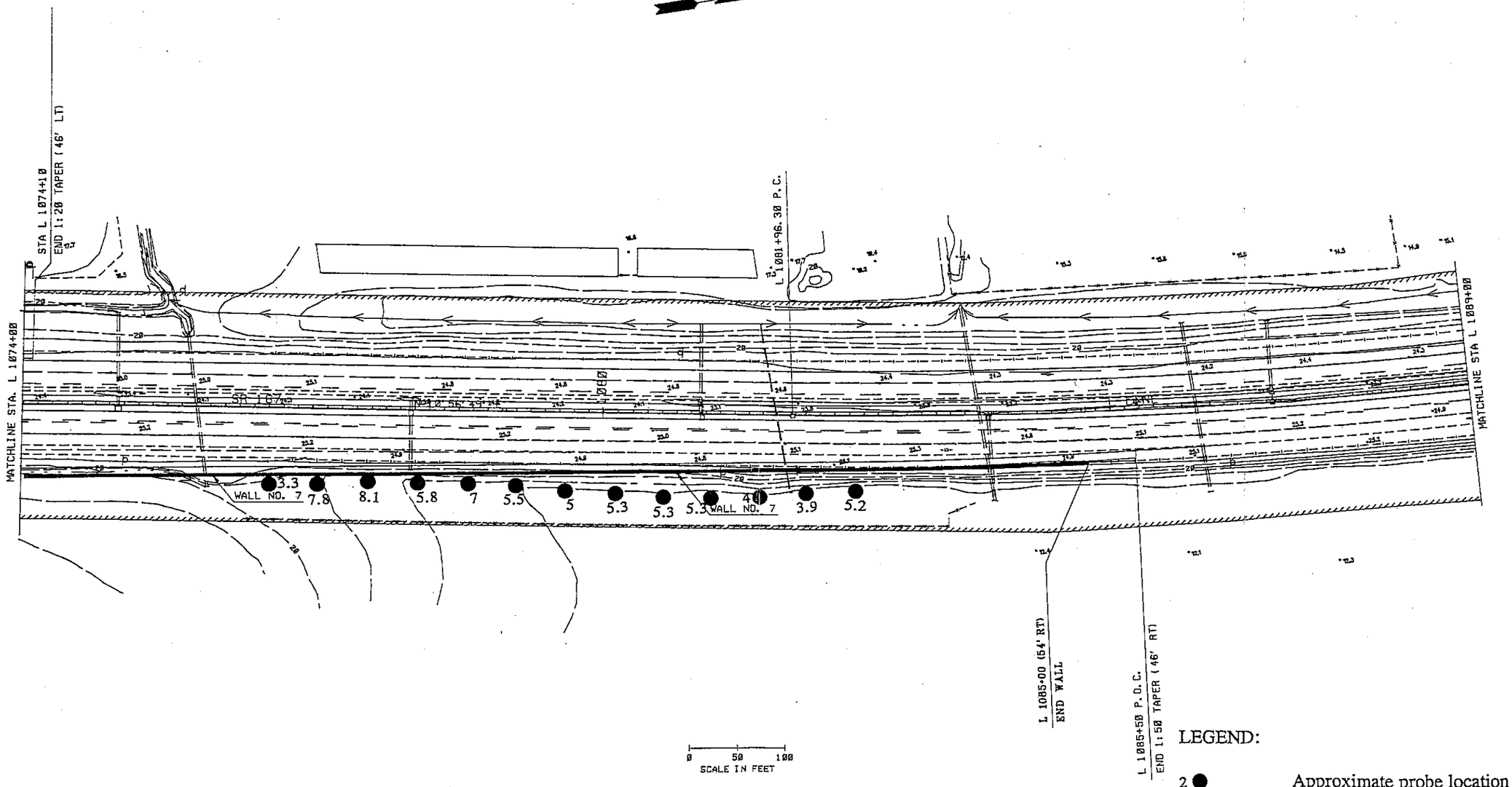
SR-167 HOV LANES

SITE & EXPLORATION PLAN
S. 212th ST. INTERCHANGE
EW-S RAMP

PROJECT: 91101-2 FIGURE: 7

91101-B-017.0

T.23N., R5E., W.M.



LEGEND:

2 ● Approximate probe location and depth of penetration in feet

Base map prepared and provided by WSDOT

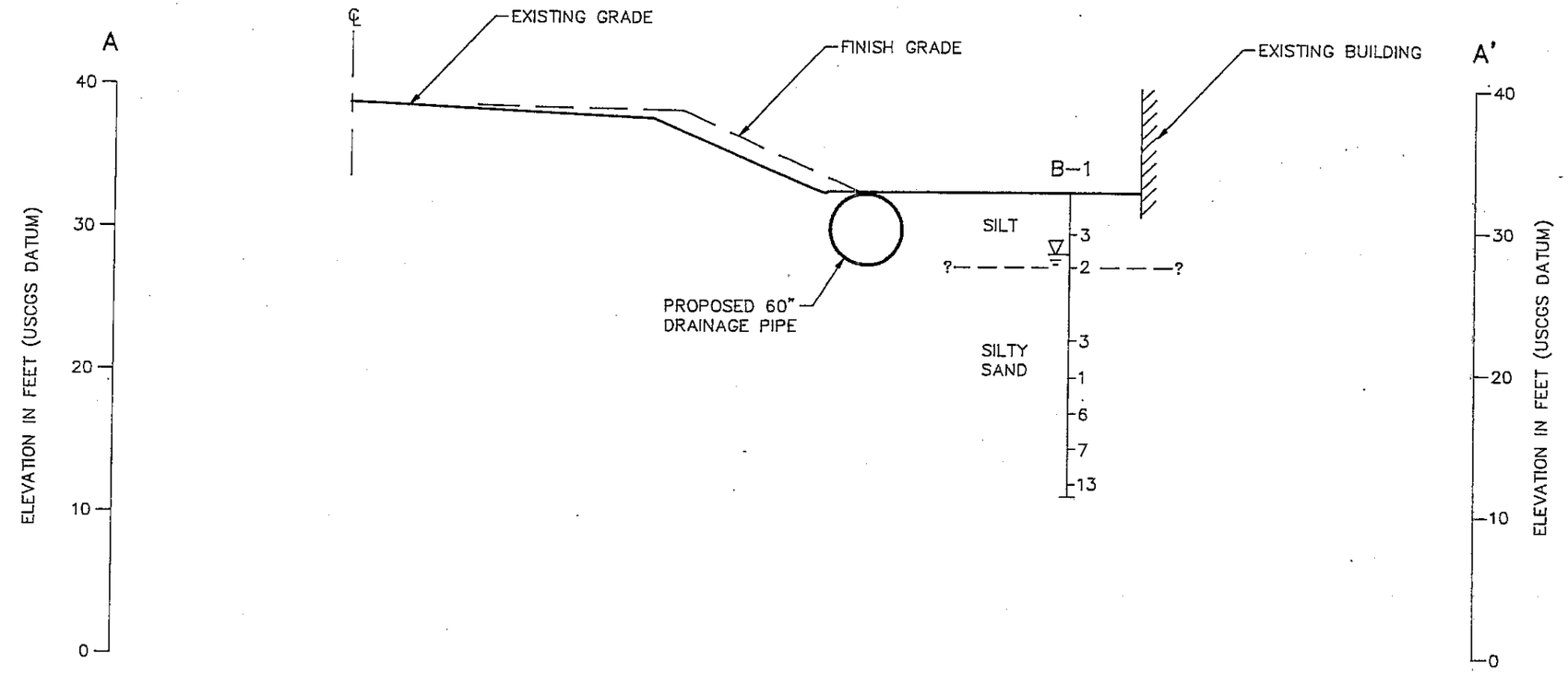
HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

SITE & EXPLORATION PLAN
STA. L 1075+00 TO
STA. L 1082+00

PROJECT: 91101-2 FIGURE: 8

91101-B-017.0



LEGEND

B–1 APPROXIMATE BOREHOLE LOCATION

APPROXIMATE WATER LEVEL DURING DRILLING

?— — — — ? APPROXIMATE GEOLOGIC CONTACT

3 SPT N–VALUE

0 5 10 20

SCALE: 1"=10'

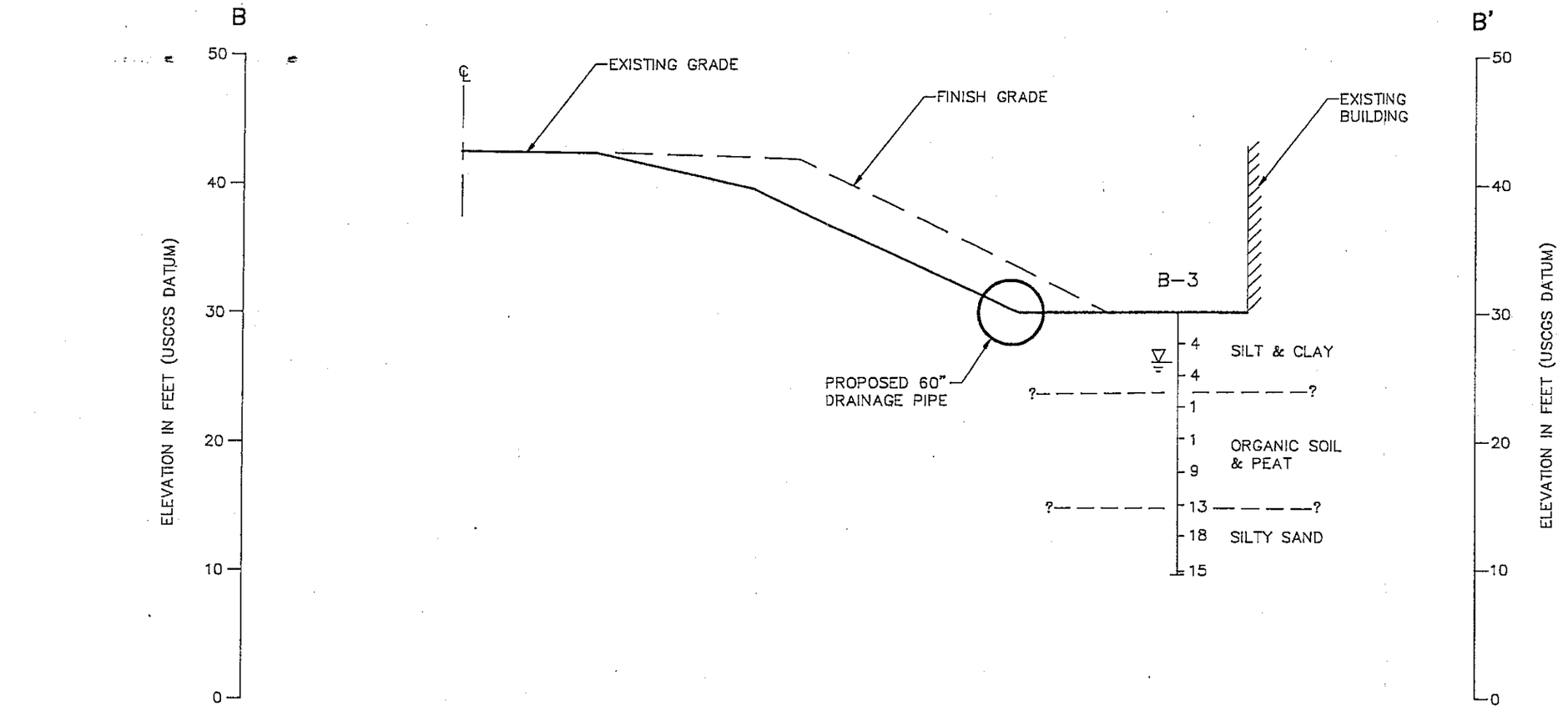
HWA HONGWEST & ASSOCIATES, INC.

SR–167 HOV LANES

CROSS SECTION A–A'
84th AVE. S. INTERCHANGE
STA. DR1 893+70

PROJECT: 91101–2 FIGURE: 9

008.1



LEGEND

B-1 APPROXIMATE BOREHOLE LOCATION

APPROXIMATE WATER LEVEL DURING DRILLING

APPROXIMATE GEOLOGIC CONTACT

3 SPT N-VALUE

0 5 10 20

SCALE: 1"=10'

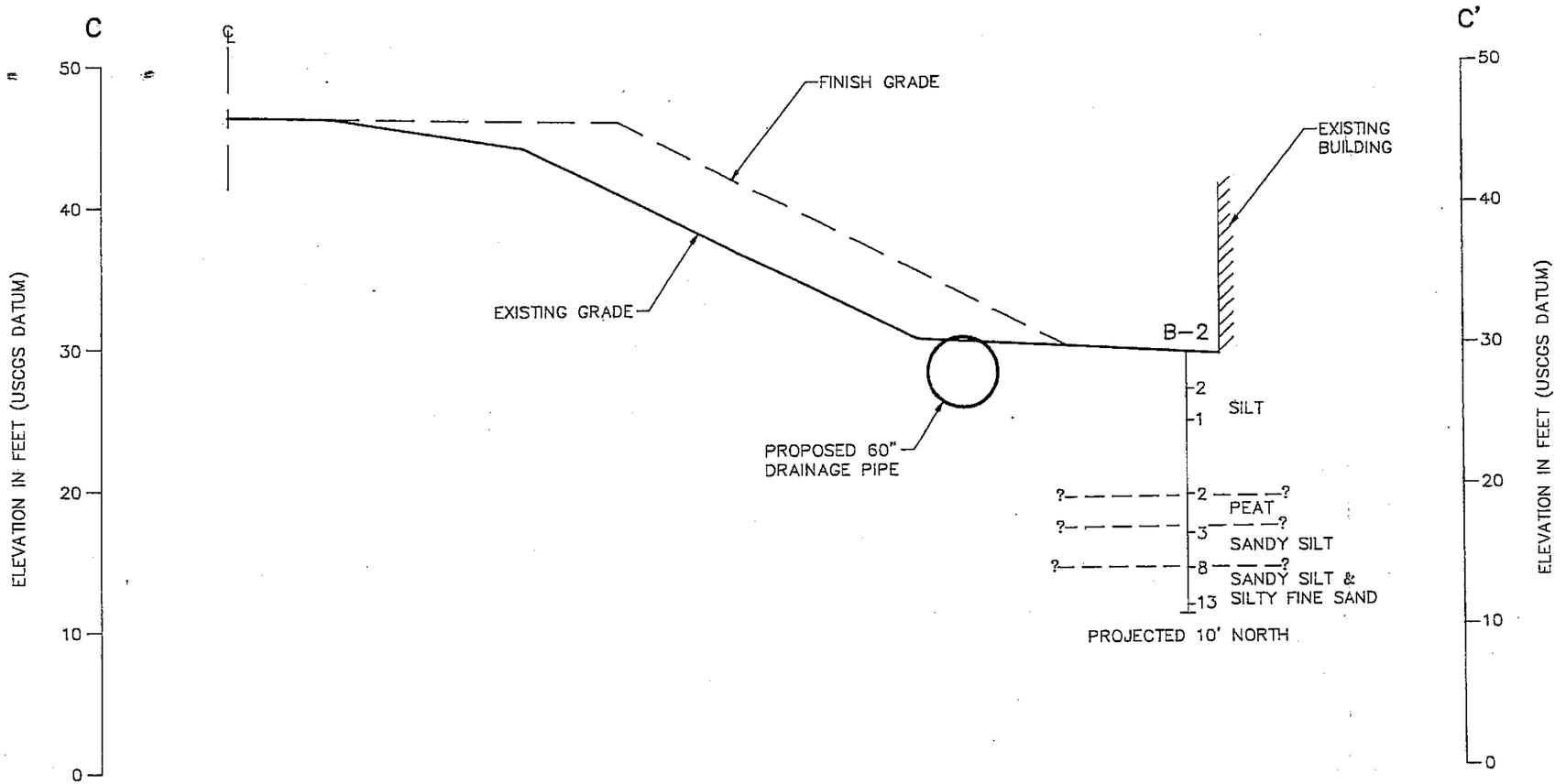
HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION B-B'
84th AVE. S. INTERCHANGE
STA. DR1 895+00

PROJECT: 91101-2 FIGURE: 10

91101-B-009.1



LEGEND

B-1 APPROXIMATE BOREHOLE LOCATION

APPROXIMATE WATER LEVEL DURING DRILLING

APPROXIMATE GEOLOGIC CONTACT

3 SPT N-VALUE

0 5 10 20

SCALE: 1"=10'

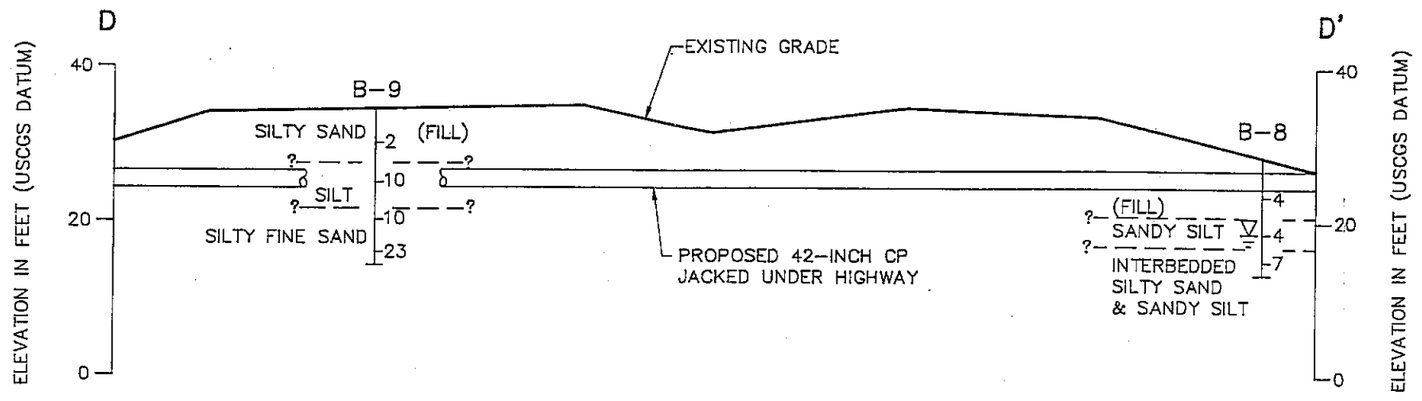
HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION C-C'
84th AVE. S. INTERCHANGE
STA. DR1 897+00

PROJECT: 91101-2 FIGURE: 11

91101-B-010.1



LEGEND

B-8 APPROXIMATE BOREHOLE LOCATION

APPROXIMATE WATER LEVEL DURING DRILLING

APPROXIMATE GEOLOGIC CONTACT

3 SPT N-VALUE

0 10 20 40

SCALE: 1"=20'

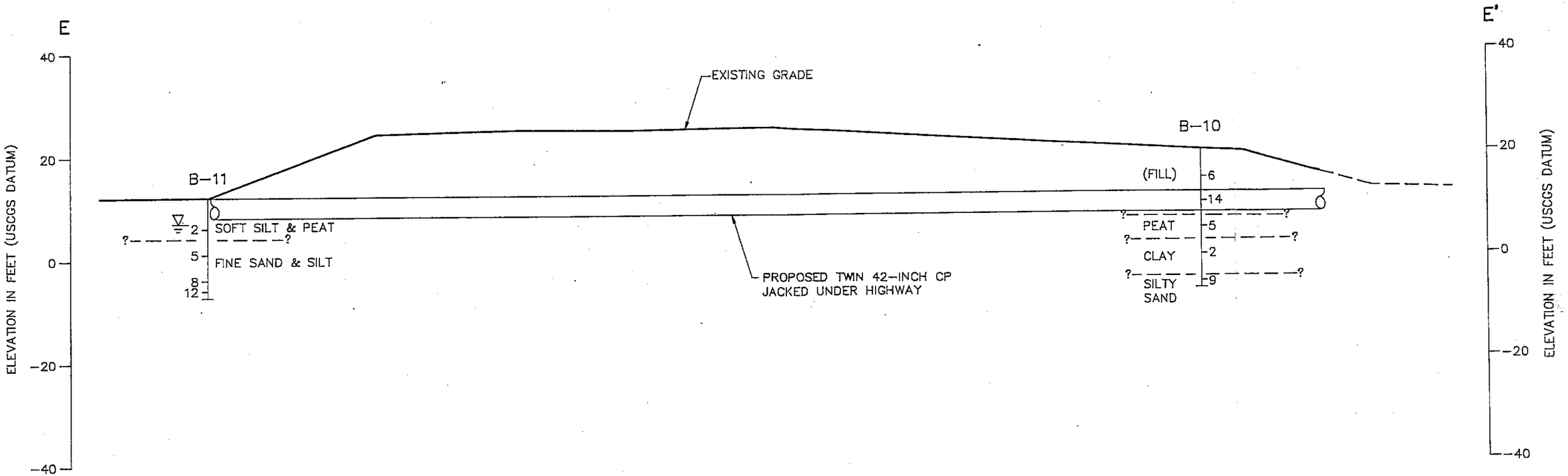
HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION D-D'
CULVERT CROSSING AT
STA. L 909

PROJECT: 91101-2 FIGURE: 12

91101-B-011.1



LEGEND

B-1 APPROXIMATE BOREHOLE LOCATION

APPROXIMATE WATER LEVEL DURING DRILLING

APPROXIMATE GEOLOGIC CONTACT

3 SPT N-VALUE

0 10 20 40

SCALE: 1"=20'

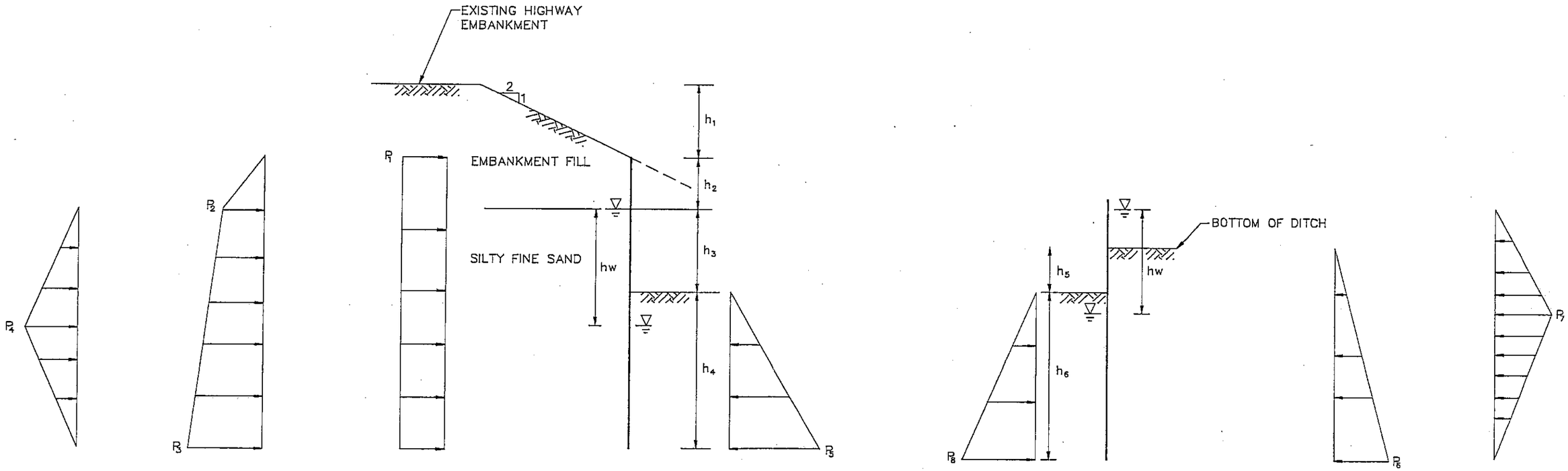
HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION E-E'
CULVERT CROSSING AT
STA. L 1120+70

PROJECT: 91101-2 FIGURE: 13

91101-B-012.1



NET PORE PRESSURE | ACTIVE EARTH PRESSURE | SURCHARGE | PASSIVE EARTH PRESSURE | PASSIVE EARTH PRESSURE | ACTIVE EARTH PRESSURE | NET PORE PRESSURE

SURCHARGE	$P_1 = 18\ h_1$
ACTIVE EARTH PRESSURE	$P_2 = 35\ h_2$ $P_3 = P_2 + 18(h_3 + h_4)$
NET PORE PRESSURE	$P_4 = 62.4\ hw$
PASSIVE EARTH PRESSURE	$P_5 = 120\ h_4$

NOT TO SCALE

ACTIVE EARTH PRESSURE	$P_6 = 18(h_5 + h_6)$
NET PORE PRESSURE	$P_7 = 62.4\ hw$
PASSIVE EARTH PRESSURE	$P_8 = 120\ h_6$

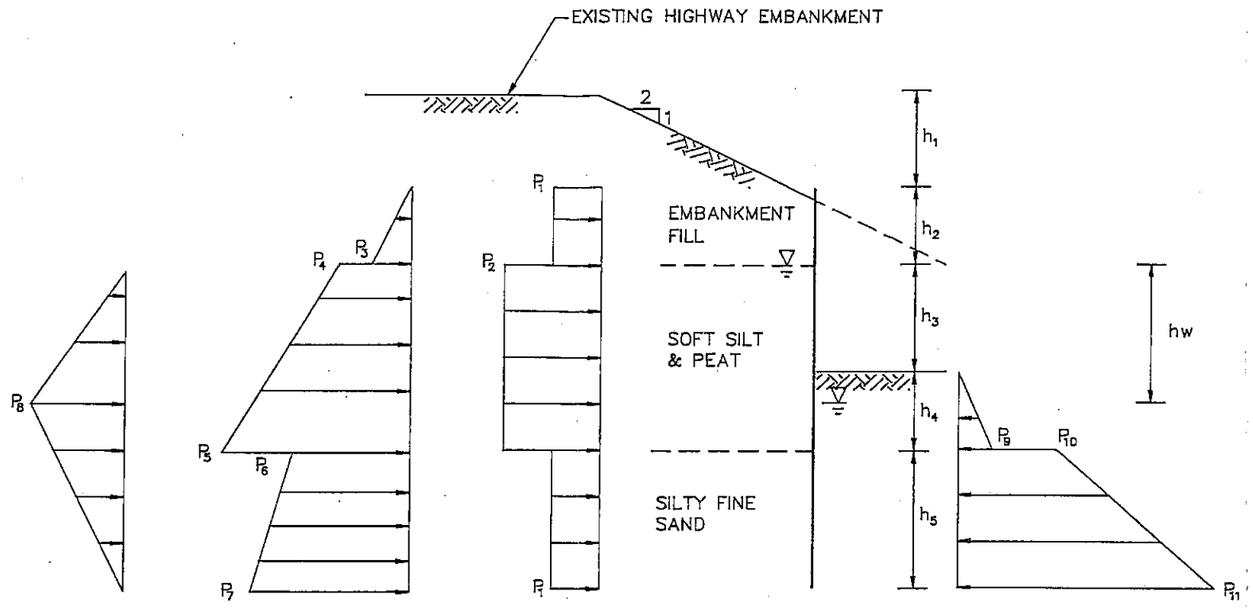
NOTE: ALL UNITS IN FEET AND POUNDS

HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

DESIGN PRESSURES FOR SHORING WALLS AT STA. L 909

PROJECT: 91101-2 FIGURE: 14



NET PORE PRESSURE | ACTIVE EARTH PRESSURE | SURCHARGE | PASSIVE EARTH PRESSURE

NOT TO SCALE

SURCHARGE	$P_1 = 18h_1$ $P_2 = 60h_1$
ACTIVE EARTH PRESSURE	$P_3 = 35h_2$ $P_4 = 120h_2$ $P_5 = 120h_2 + 50(h_3 + h_4)$ $P_6 = 35h_2 + 15(h_3 + h_4)$ $P_7 = P_6 + 18h_5$
NET PORE PRESSURE	$P_8 = 62.4\ hw$
PASSIVE EARTH PRESSURE	$P_9 = 50h_4$ $P_{10} = 100h_4$ $P_{11} = P_{10} + 120h_5$

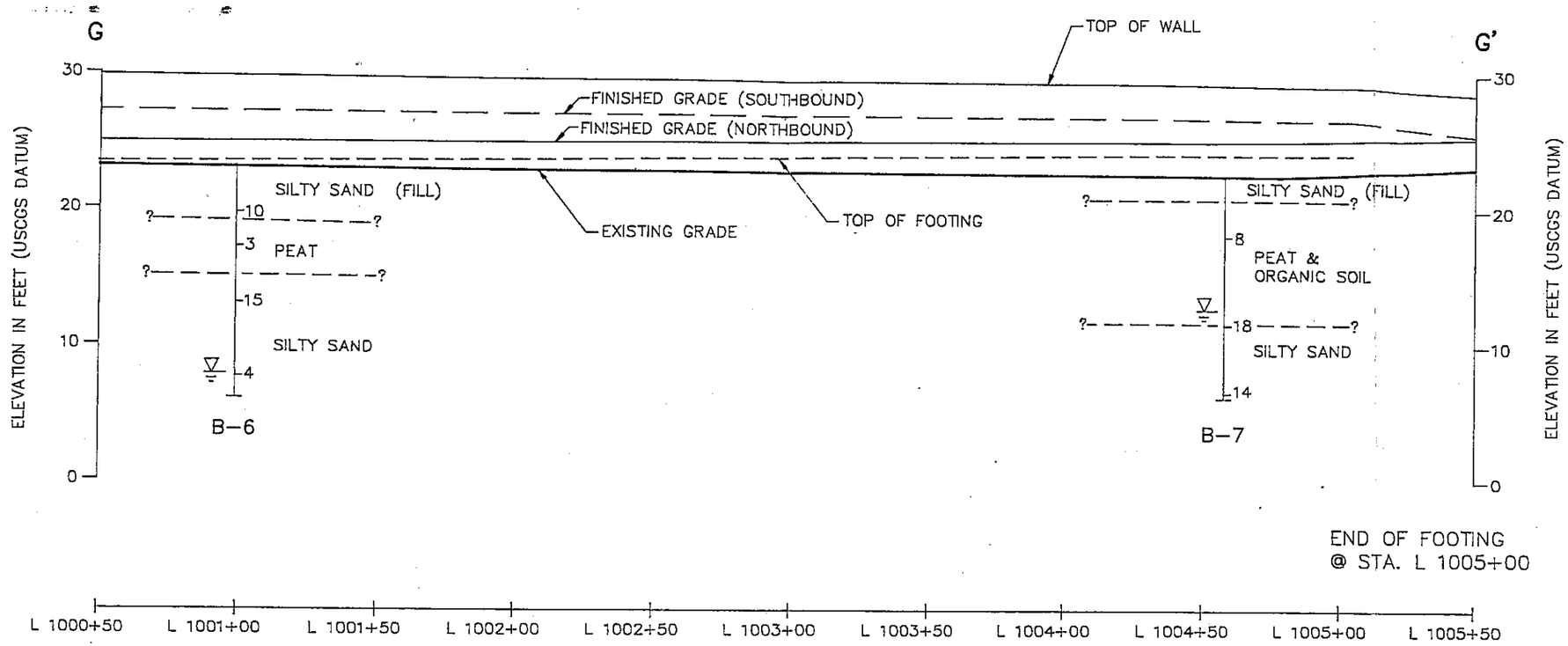
NOTE: ALL UNITS IN FEET AND POUNDS

HWA HONGWEST & ASSOCIATES, INC.

SR–167 HOV LANES

DESIGN PRESSURES FOR SHORING WALLS AT STA. L 1120+70

PROJECT: 91101–2 FIGURE 15



LEGEND

- APPROXIMATE WATER LEVEL DURING DRILLING
- APPROXIMATE GEOLOGIC CONTACT
- 3 SPT N-VALUE
- B-6 APPROXIMATE BOREHOLE LOCATION

Profile prepared and provided by WSDOT.

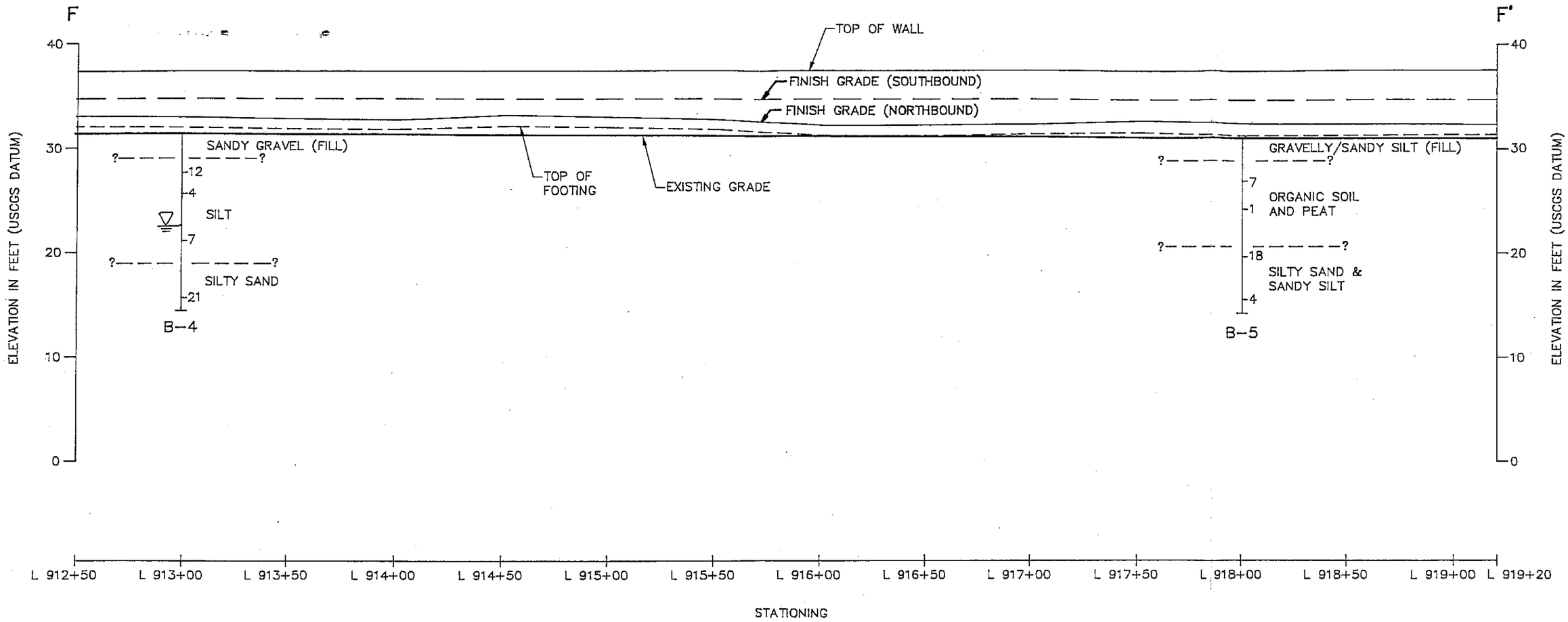
91101-B-014.0

HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION G-G'
PROFILE ALONG MEDIAN
STA. L 1000+00 TO
STA. L 1005+50

PROJECT: 91101-2 FIGURE: 17



LEGEND

- APPROXIMATE WATER LEVEL DURING DRILLING
- APPROXIMATE GEOLOGIC CONTACT
- 3 SPT N-VALUE
- B-4 APPROXIMATE BOREHOLE LOCATION

Profile prepared and provided by WSDOT.

HWA HONGWEST & ASSOCIATES, INC.

SR-167 HOV LANES

CROSS SECTION F-F'
PROFILE ALONG MEDIAN
STA. L 912+50 TO STA. L 919+20

PROJECT: 91101-2 FIGURE: 16

91101-B-013.1

APPENDIX A

FIELD EXPLORATION

HONG WEST & ASSOCIATES, INC.

APPENDIX A
FIELD EXPLORATION

EXPLORATORY BORINGS

On February 10, 24 and 25, 1993, personnel from Hong West & Associates (HWA) monitored subsurface exploration at the project site. A total of 11 exploratory borings to maximum depth of 26 feet deep were drilled at locations indicated on Figures 2 through 6, the Site and Exploration Plans, as summarized below:

Boring No.	Location	Total Depth (ft.)	Surface Elevation (ft.)
B-1	84th Ave. S. Interchange Sta. DR1 893+70, 50' Rt.	20.5	30±
B-2	84th Ave. S. Interchange Sta. DR1 896+90, 67' Rt.	18	30±
B-3	84th Ave. S. Interchange Sta. DR1 895+00, 55' Rt.	20.5	30±
B-4	Sta. L 913+00, CL.	16.5	31±
B-5	Sta. L 918+00, CL.	16.5	30±
B-6	Sta. L 1101+00, 6' Lt.	16.5	23±
B-7	Sta. L 1004+55, CL.	16.5	23±
B-8	Sta. L 908+70, 80' Rt.	15.5	34±
B-9	Sta. L 909+15, 55' Lt.	20	35±
B-10	Sta. L 1120+60, 110' Rt.	26	22±
B-11	Sta. L 1120+70, 80' Lt.	18.5	12±

Borings B-1 through B-10 were drilled with a small trailer-mounted continuous flight hollow stem auger rig (Mobil Drill B-24). A small, portable power drill rig (Acker Drill) was used in boring B-11 because of access difficulty. The soil samples extracted from the borings were examined, classified and logged in the field by a geotechnical engineer of HWA. The boring logs are included in this appendix.

Samples were taken with a standard 2-inch (outside diameter) split spoon sampler, driven 18 inches into undisturbed soils beyond the auger bit by dropping a 140 pound hammer 30 inches per stroke. The number of blows to accomplish each 6 inches of penetration was recorded, and the number of blows required to drive the last 12 inches were totaled as the Standard Penetration Test (SPT) blowcount, or N-value. The N-values are plotted on the boring logs, and are used as an index to correlate certain soil properties.

Relatively undisturbed soil samples were obtained in the soft soil strata using Shelby tubes. The samples obtained from the borings were sealed in airtight containers and returned to HWA's laboratory for further study and testing.

The exploratory operation was monitored for indications of various drilling conditions, such as hard drilling and soft drilling. Sample rods were monitored for indications of groundwater.

PROBING

On March 11 and 12, 1993, HWA personnel conducted manual probing of surficial soil at the following locations:

- 84th Ave. S. Interchange, DR1 Ramp, Sta. DR1 896+00 to Sta. L 904+00
- S. 212th Street Interchange, E-WS Ramp, Sta. EW-S 41+30 to Sta. EW-S 45+70
- S. 180th St. Interchange, DR2 Ramp, Sta. 1075+00 to Sta. 1082+00

The probings were performed by manually forcing a 0.625-inch diameter steel probe into the ground. A total of 37 probes were conducted at locations indicated on Figures 2, 3, 7 and 8. The purpose of the probing was to survey the thickness of the unsuitable, soft soil at these locations.

LEGEND OF TERMS USED ON EXPLORATION SOIL LOGS

Soil classifications presented on the exploration soil logs are based on visual field and laboratory observations, using ASTM D 2488. Soil descriptions are presented in the following general order: Density/consistency, color, modifier, MAJOR CONSTITUENT, minor constituent(s), moisture content, soil structure(s), additional remarks.

DENSITY/CONSISTENCY

Density/consistency of soils encountered in exploratory borings is usually based on the Standard Penetration Test (SPT) N-value or "blowcount", ASTM D 1586. Using this method, the sampler is driven 18 inches with a 140-pound hammer falling 30 inches. The SPT N-value is the number of blows for the last 12 inches of sampler drive.

Granular Soil Density	SPT N-value	Cohesive Soil Consistency	SPT N-value	Unconfined Compressive Strength (tsf)
Very loose	0 - 4	Very soft	0 - 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.5
Medium dense	10 - 30	Medium stiff	4 - 8	0.5 - 1.0
Dense	30 - 50	Stiff	8 - 15	1.0 - 2.0
Very dense	> 50	Very stiff	15 - 30	2.0 - 4.0
		Hard	> 30	> 4.0

MOISTURE CONTENT

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

MINOR CONSTITUENTS

	Estimated Percentage
Trace	0 - 5
Some	5 - 12
Modifier (sandy, silty, etc.)	12 - 30
Very (plus modifier)	30 - 50

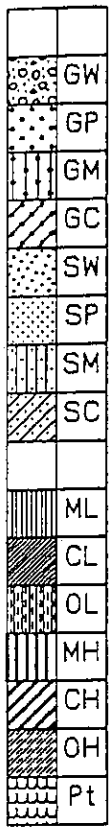
TERMS DESCRIBING SOIL STRUCTURES

Bedded	Composed of layers thicker than 1 cm, of varying color and/or texture.
Calcareous	Containing a significant amount of calcium carbonate.
Cemented	Rock or soil hardened by the precipitation of a mineral cement among the grains of the sediment.
Fissured	Containing shrinkage cracks, frequently filled with fine sand or silt, usually more or less vertical.
Indurated	A rock or soil hardened or consolidated by pressure, cementation, or heat.
Interbedded	Composed of alternating beds of different soil types.
Laminated	Composed of thin (< 1 cm) layers of varying color and/or texture.
Poorly graded	Predominantly a single grain size, or having some intermediate sizes missing ("gap" graded).
Slickensided	Having previously-sheared planes of weakness that are slick and glossy in appearance.
Well graded	Having a wide range of grain sizes, with substantial amounts of intermediate particle sizes.

HONGWEST
& ASSOCIATES, INC.

LEGEND OF SYMBOLS USED ON EXPLORATION SOIL LOGS

GRAPHIC SYMBOLS FOR SOIL TYPES



NON-COHESIVE SOILS (<50% passing No. 200 sieve)

- GW — well graded gravel and gravel/sand mix
- GP — poorly graded gravel, gravel/sand mix
- GM — silty gravel, gravel/sand/silt mix
- GC — clayey gravel, gravel/sand/clay mix
- SW — well graded sand, gravelly sand
- SP — poorly graded sand, little or no fines
- SM — silty sand, sand/silt mix
- SC — clayey sand, sand/clay mix

COHESIVE SOILS (>50% passing No. 200 sieve)

- ML — inorganic silt and very fine sand
- CL — inorganic, low plasticity clay
- OL — organic, low plasticity clay, silt/clay mix
- MH — inorganic, elastic silt, silt/sand mix
- CH — inorganic, high plasticity clay
- OH — organic, medium to high plasticity clay
- Pt — peat and other highly organic soil

SAMPLE TYPE SYMBOLS

BOREHOLE SAMPLES

- 2.0" OD Split Spoon (SPT)
- Shelby Tube
- 3.0" OD Split Spoon with Brass Rings
- Grab Sample (cuttings)
- Core Run

TEST PIT SAMPLES

- Bag (bulk sample)
- Grab (small volume)
- Shelby Tube

HAND BORING SAMPLES

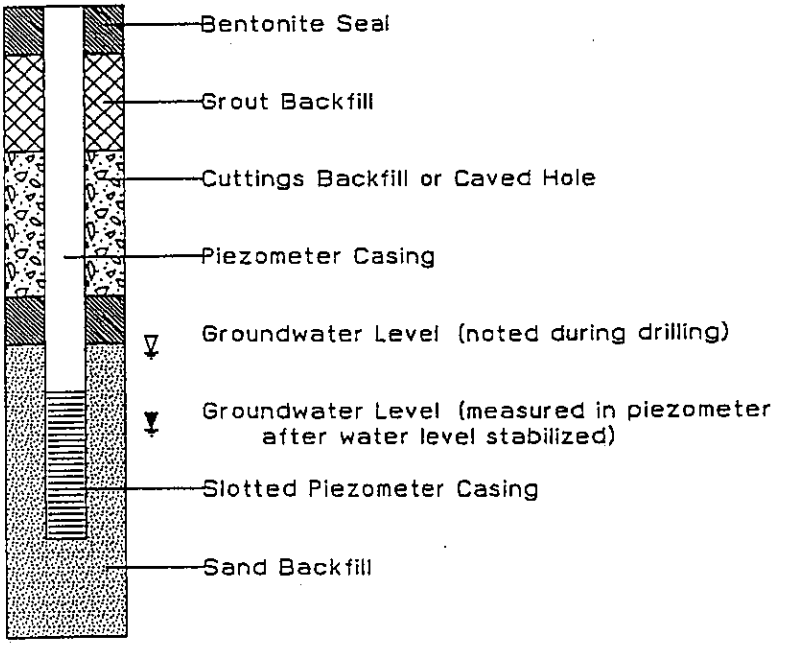
- Non-standard penetration (40 lb. hammer with 12 inch drop)
- Grab Sample (post hole)
- Shelby Tube

ROTARY BOREHOLE SAMPLES

- Continuous Core Sample

Note: The graphic symbols used for the various soil types are based on symbols recommended in the Unified Soil Classification System. Graphic logs are based on subjective field identification of soils, and laboratory data where available.

GROUNDWATER MONITORING WELL SYMBOLS



ATTERBERG LIMITS

o – Natural Moisture Content

PL – Plastic Limit

LL – Liquid Limit

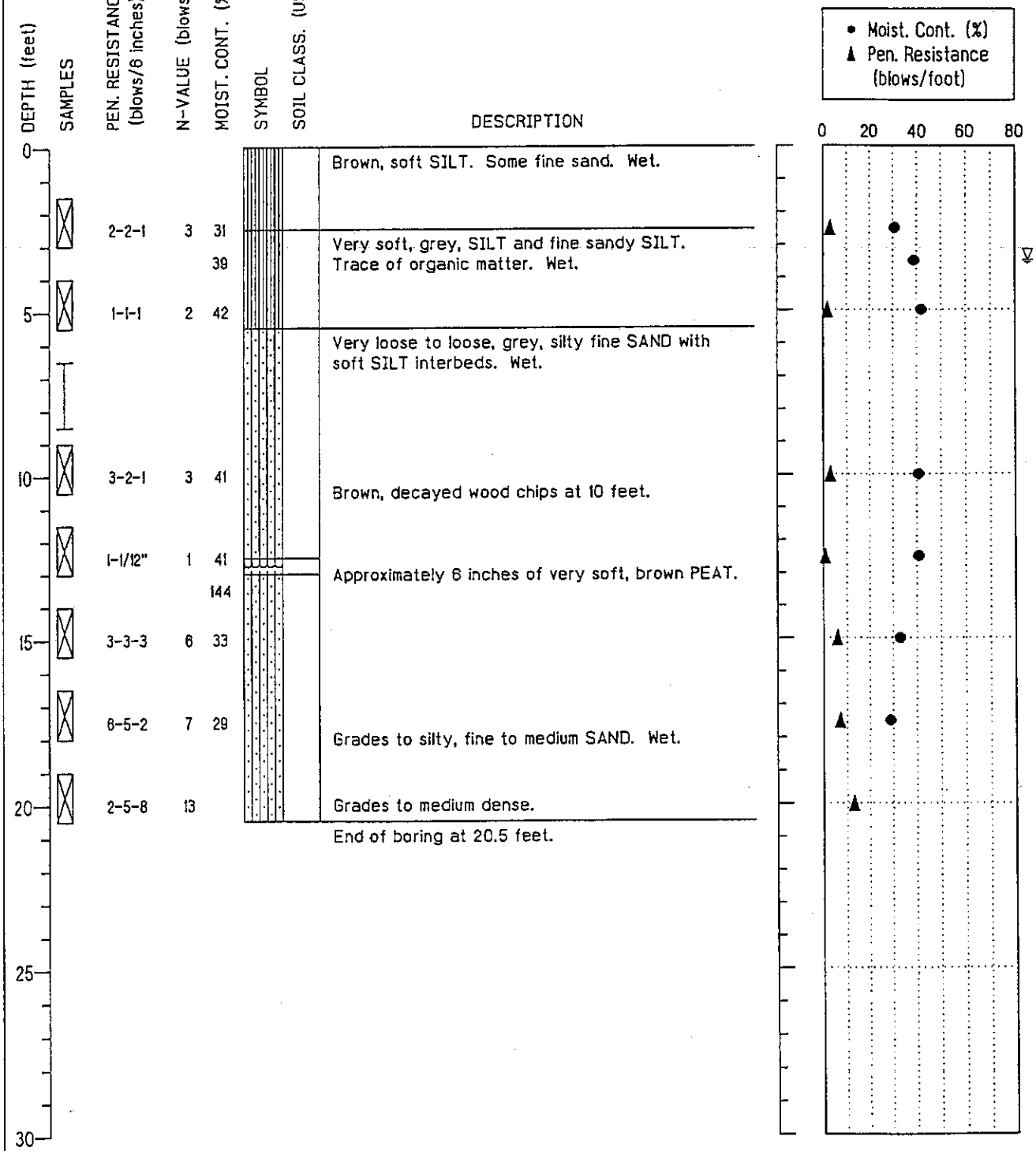
HONGWEST & ASSOCIATES, INC.

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 20.5 Feet
SURFACE ELEVATION: 30± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

BORING: B-1

LOCATION: 84th Ave. S., DR1 Ramp, Sta. 893+70 50' Right
DATE COMPLETED: Feb. 10, 1993
LOGGED BY: SLT

PROJECT NUMBER: 91101-2

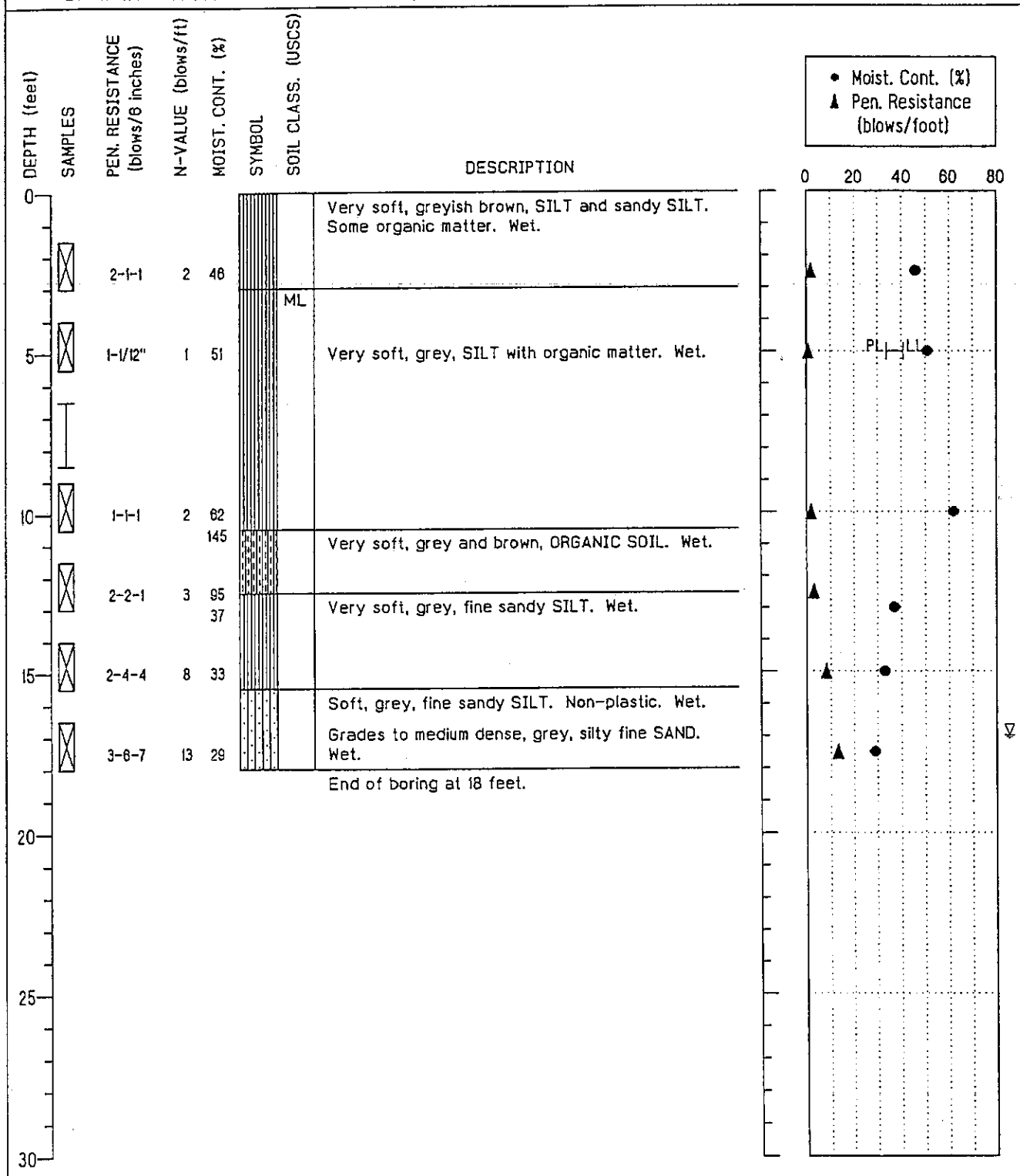
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 18 Feet
SURFACE ELEVATION: 30± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: 84th Ave. S., DR1 Ramp, Sta. 896+90 67' Right
DATE COMPLETED: Feb. 10, 1993
LOGGED BY: SLT

BORING: B-2

PROJECT NUMBER: 91101

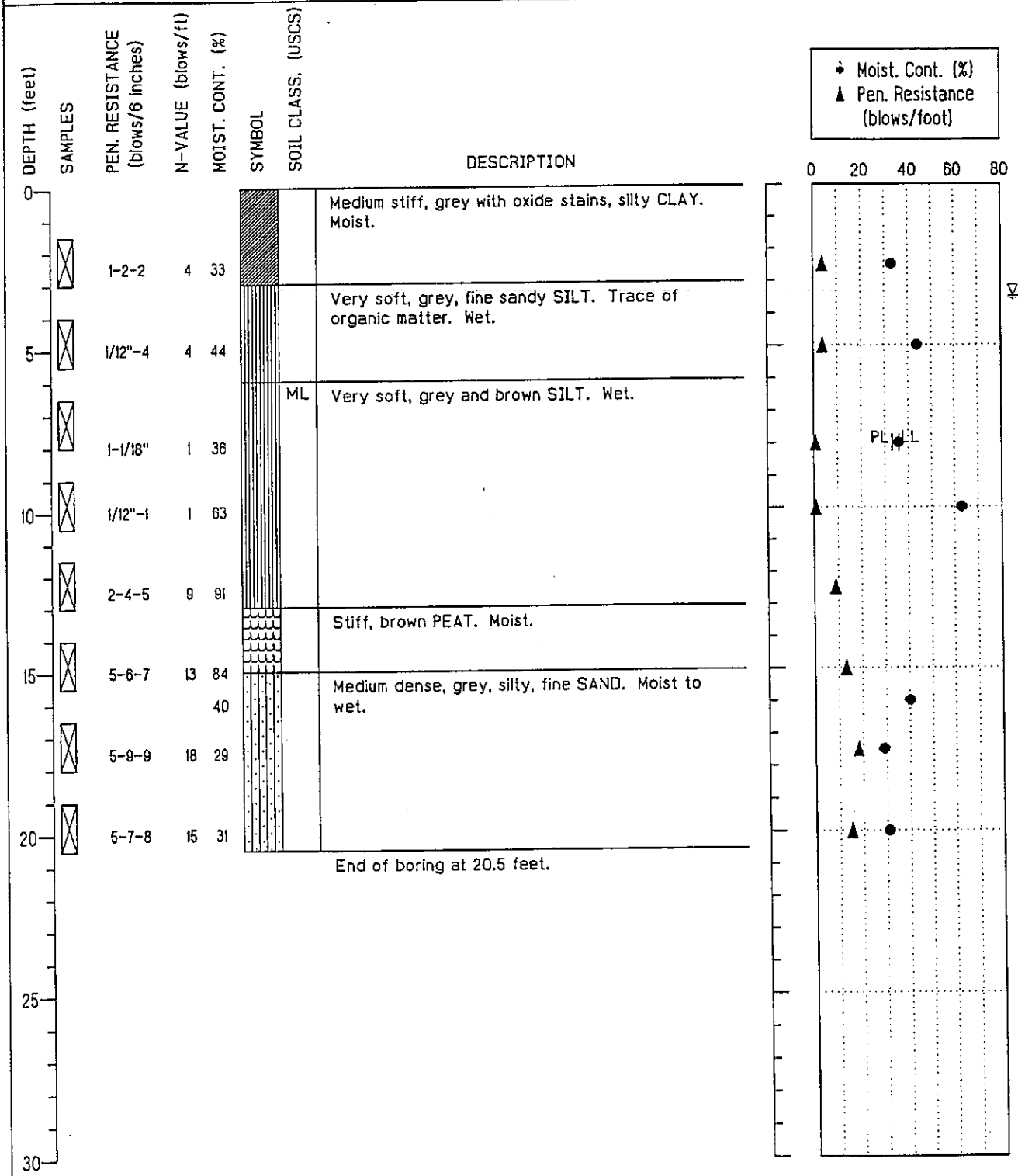
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 20.5 Feet
SURFACE ELEVATION: 30± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

BORING: B-3

LOCATION: 84th Ave. S., Sta. DR1 895+00 55' Right
DATE COMPLETED: Feb. 10, 1993
LOGGED BY: SLT

PROJECT NUMBER: 91101-2

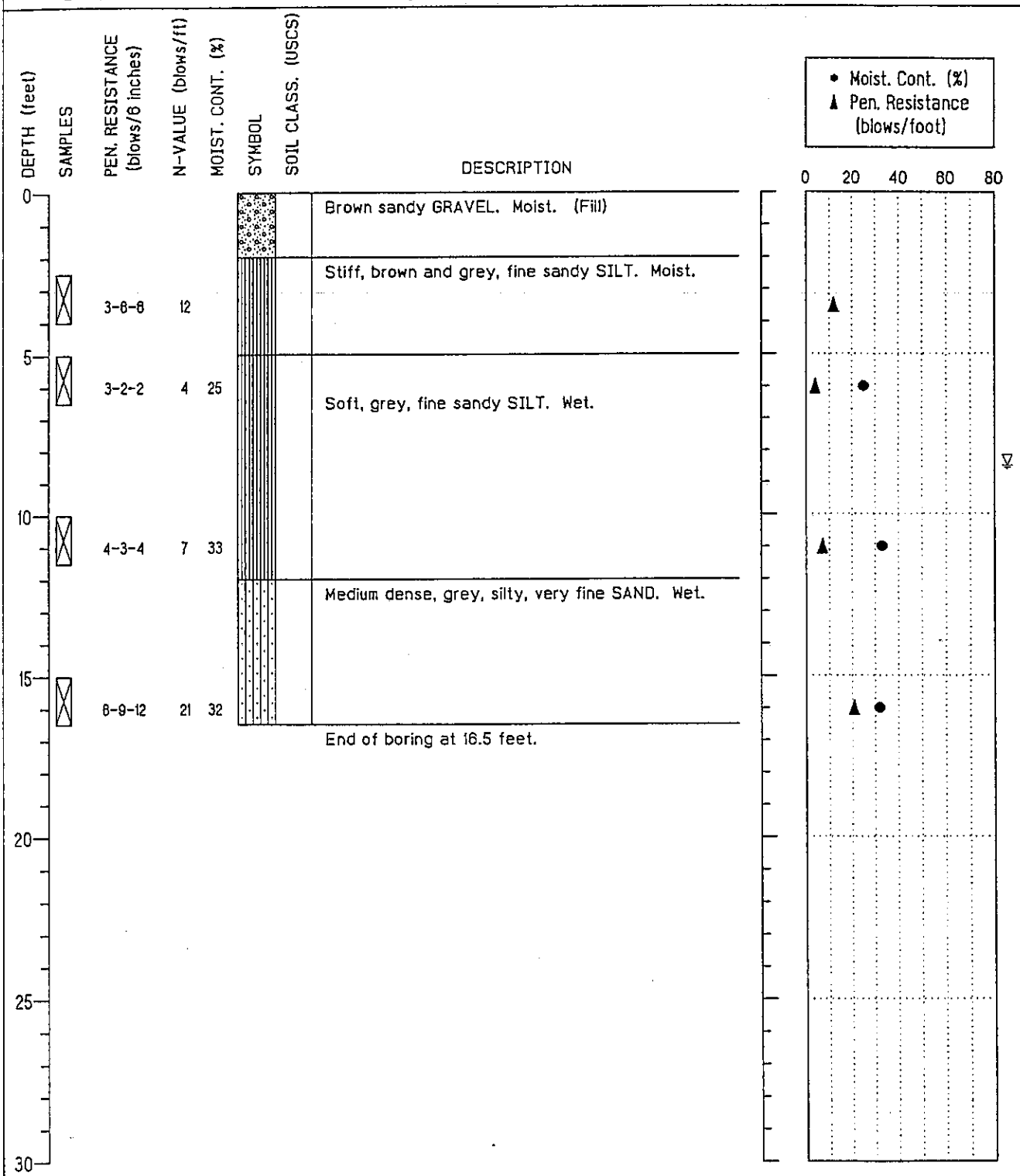
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 16.5 Feet
SURFACE ELEVATION: 31± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: Sta. L 913+00 Centerline
DATE COMPLETED: Feb. 24, 1993
LOGGED BY: SLT

BORING: B-4

PROJECT NUMBER: 91101-2

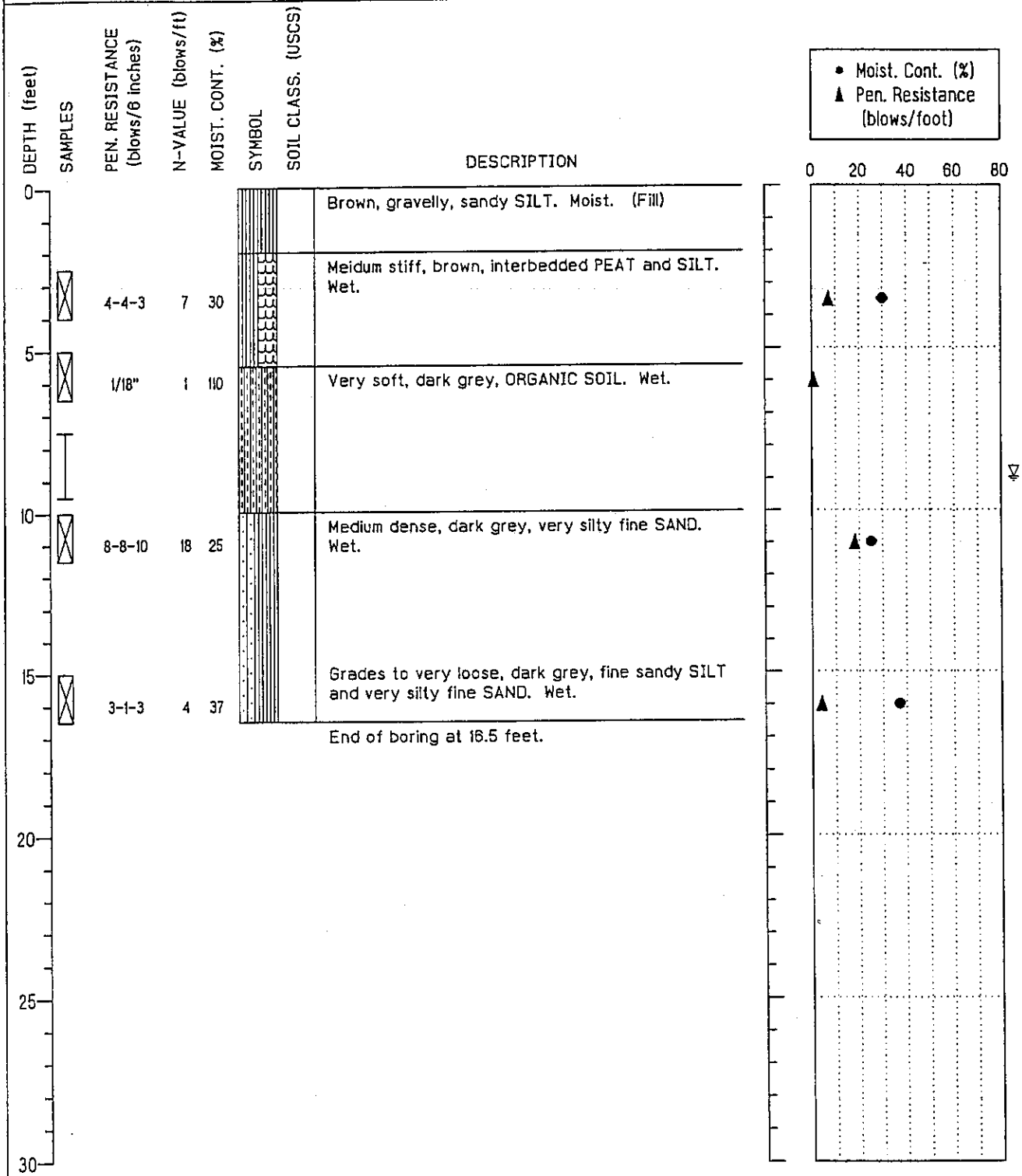
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 16.5 Feet
SURFACE ELEVATION: 30± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: Sta. L 918+00, Centerline
DATE COMPLETED: Feb. 24, 1993
LOGGED BY: SLT

BORING: B-5

PROJECT NUMBER: 91101-2

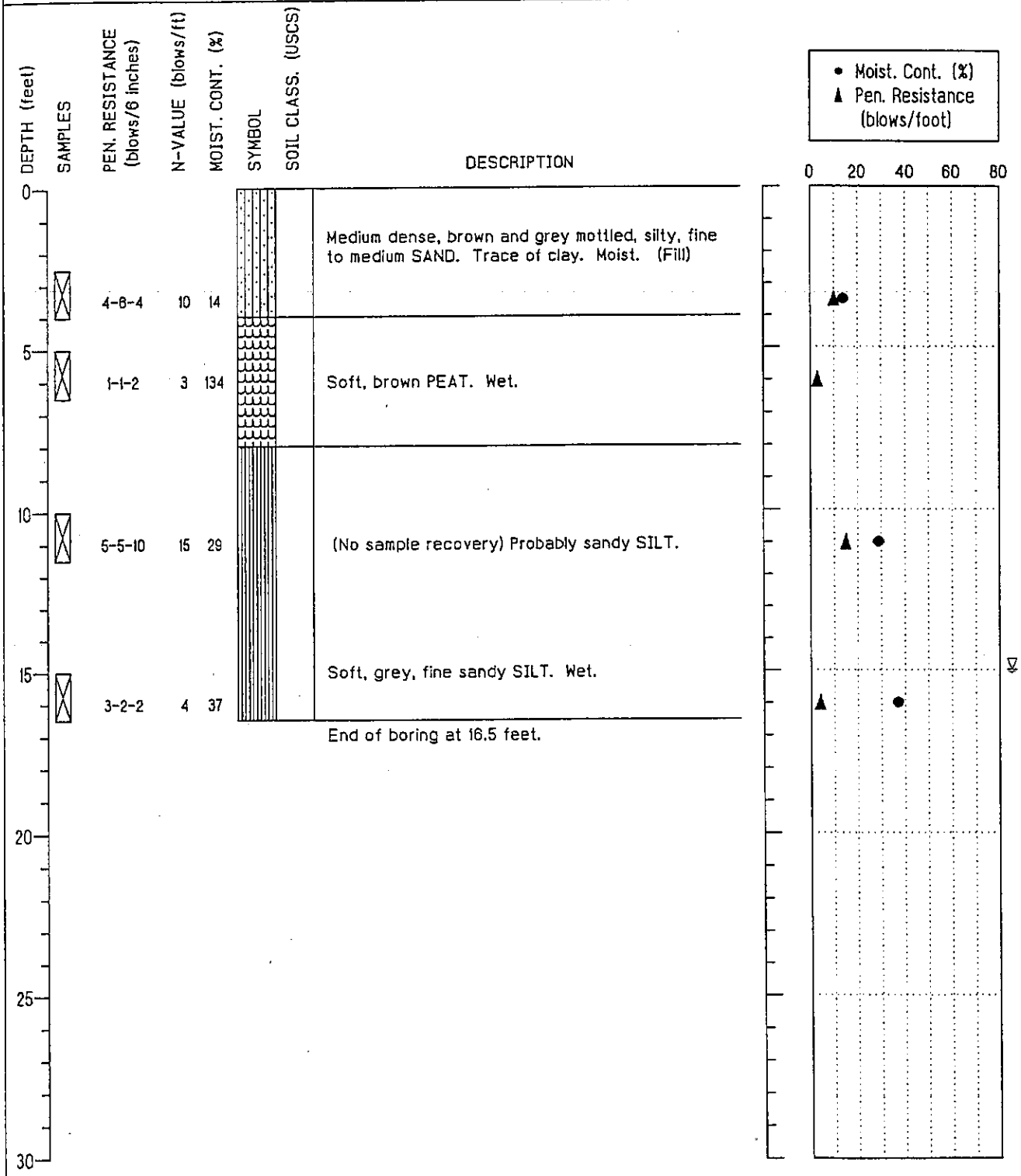
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 16.5 Feet
SURFACE ELEVATION: 23± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

BORING: B-6

LOCATION: Sta. L 1001+00, 6' left
DATE COMPLETED: Feb. 24, 1993
LOGGED BY: SLT

PROJECT NUMBER: 91101-2

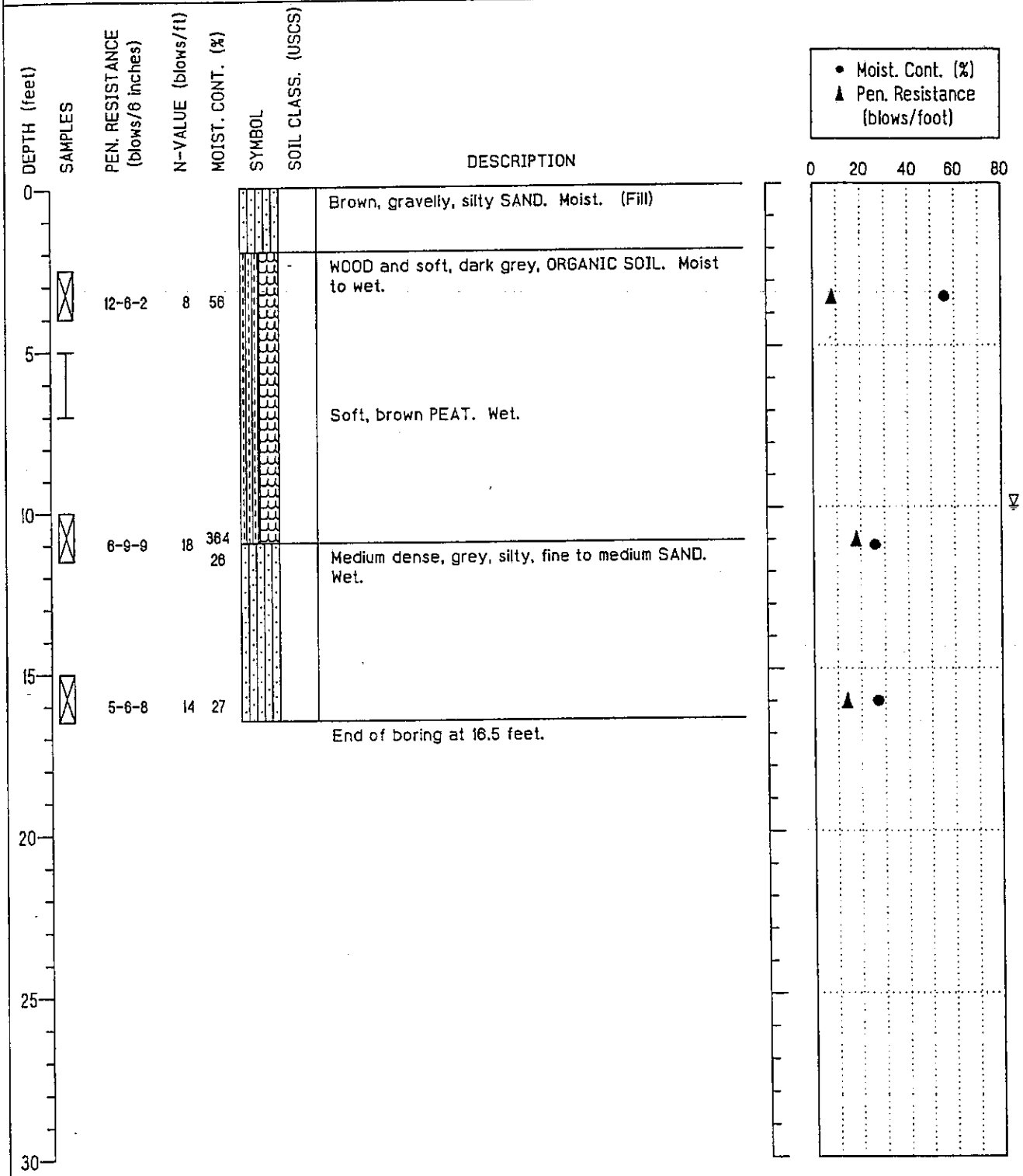
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 16.5 Feet
SURFACE ELEVATION: 23± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: Sta. L 1004+55, Centerline
DATE COMPLETED: Feb. 24, 1993
LOGGED BY: SLT

BORING: B-7

PROJECT NUMBER: 91101-2

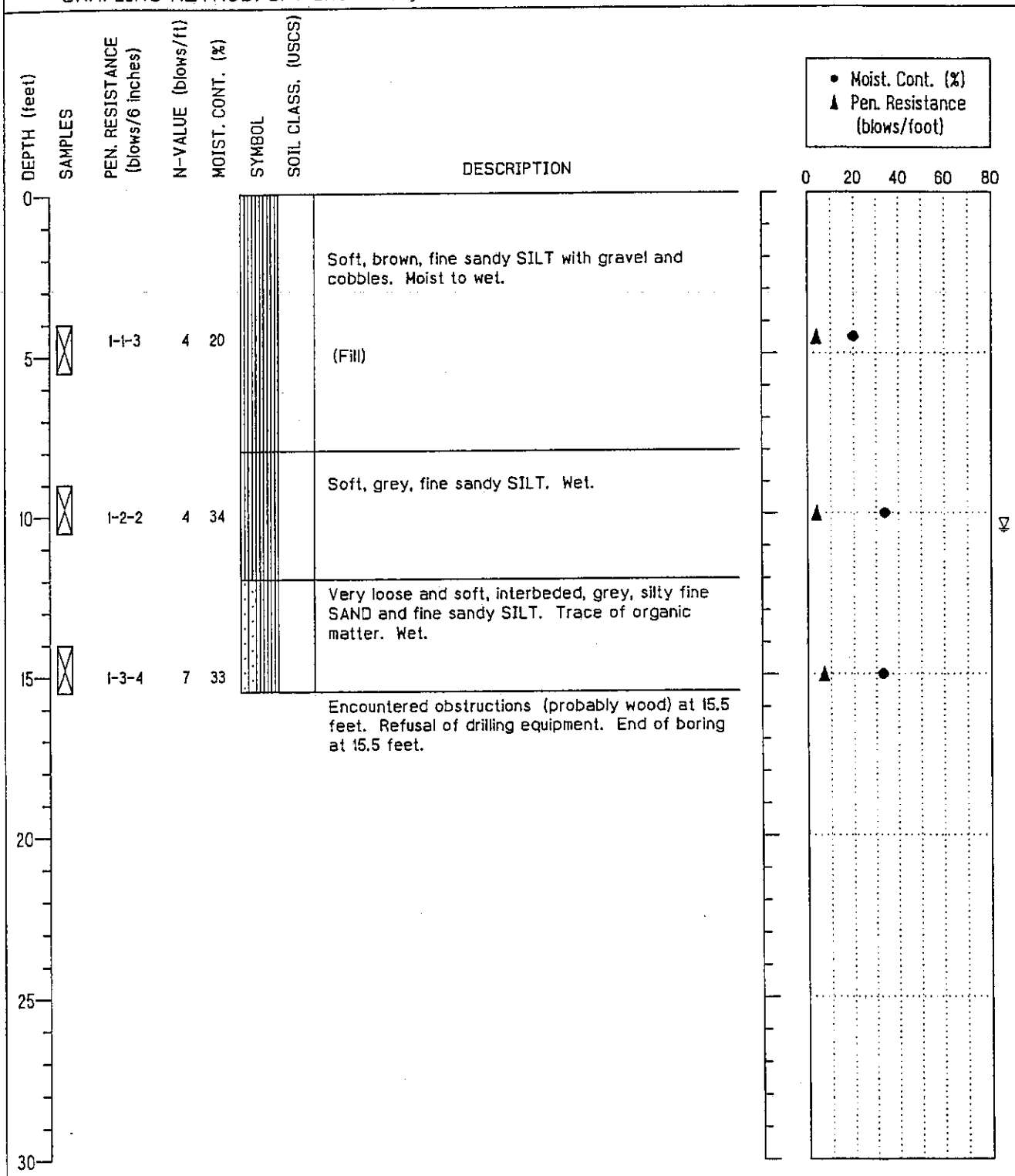
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 15.5 Feet
SURFACE ELEVATION: 34± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: Sta. L 908+70, 80' Right
DATE COMPLETED: Feb. 25, 1993
LOGGED BY: SLT

BORING: B-8

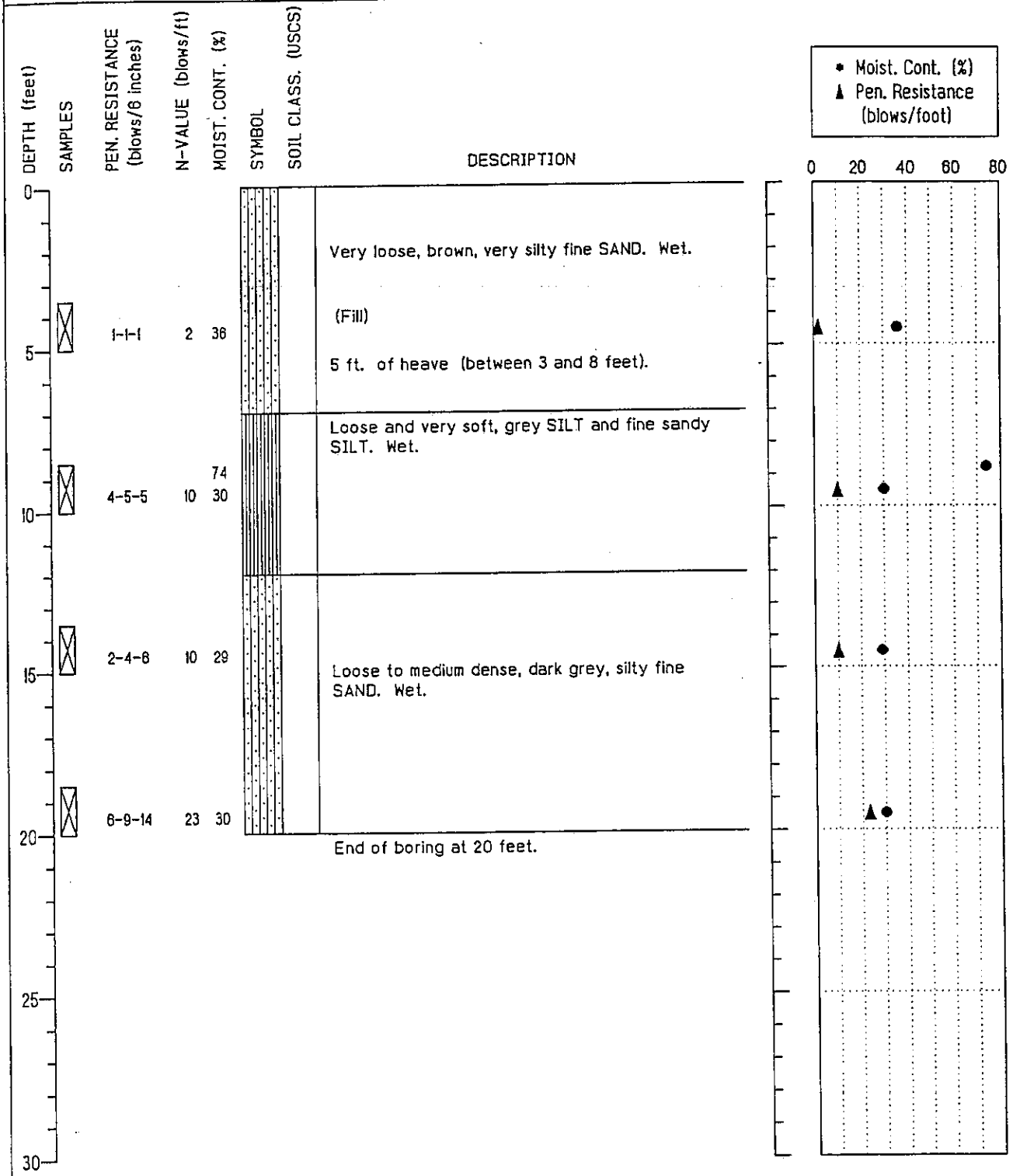
PROJECT NUMBER: 91101-2

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 20 Feet
SURFACE ELEVATION: 35± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

BORING: B-9

LOCATION: Sta. L 909+15, 55' Left
DATE COMPLETED: Feb. 25, 1993
LOGGED BY: SLT

PROJECT NUMBER: 91101-2

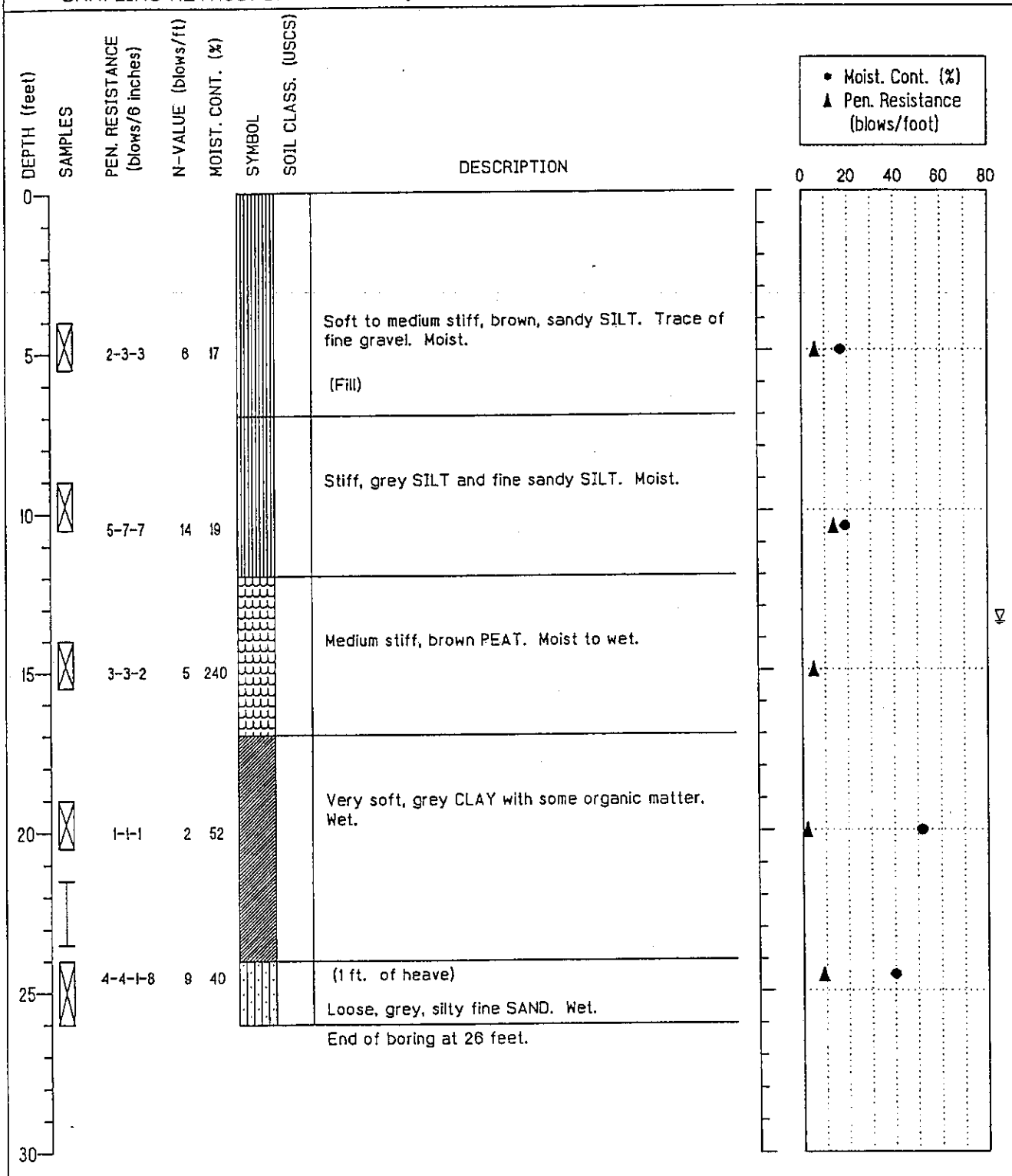
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 26 Feet
SURFACE ELEVATION: 22± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

BORING: B-10

LOCATION: Sta. L 1120+60, 110' Right
DATE COMPLETED: Feb. 25, 1993
LOGGED BY: SLT

PROJECT NUMBER: 91101-2

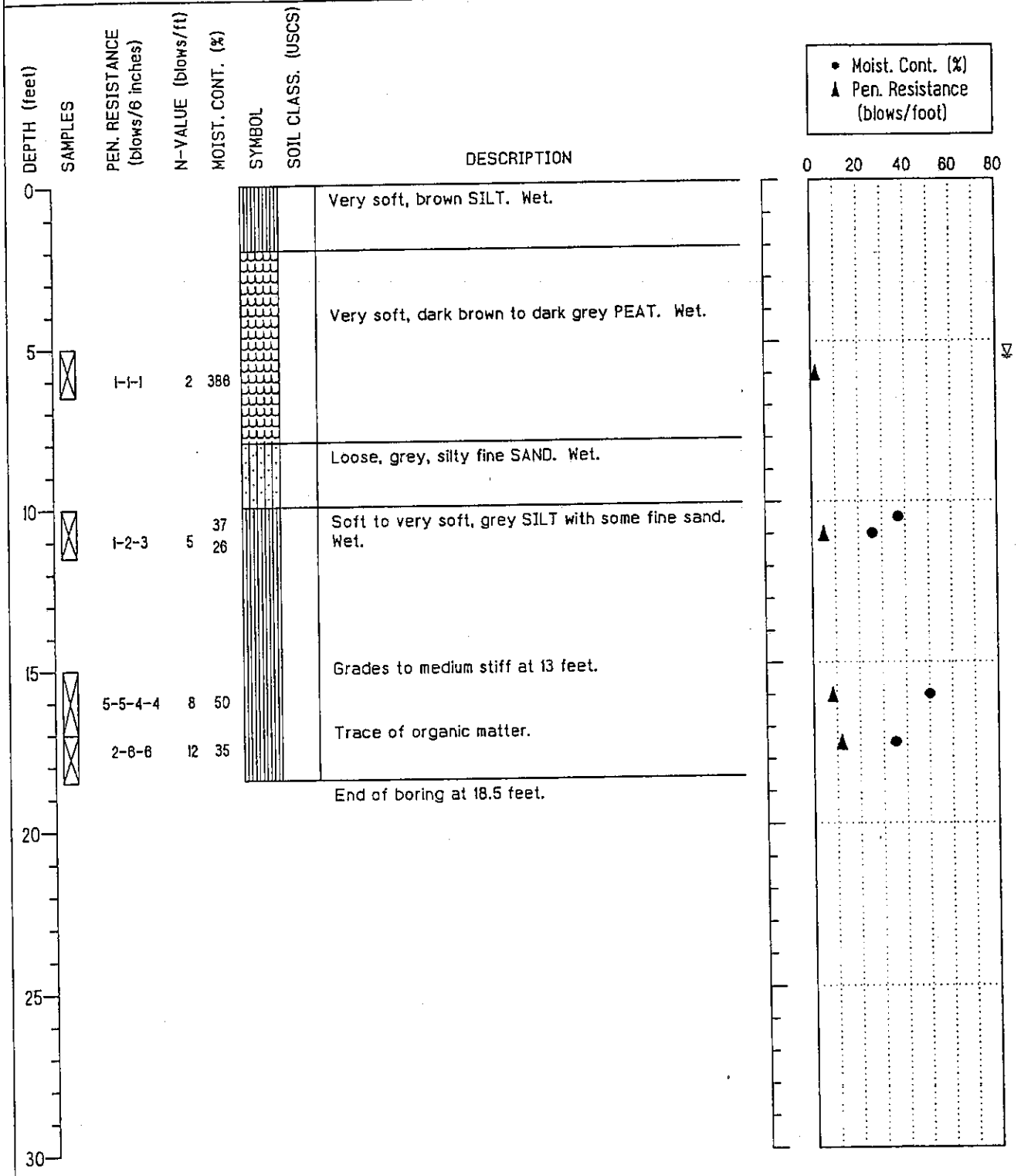
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Boretec
DRILLING METHOD: Hollow stem auger
SAMPLING METHOD: SPT and shelby tube

TOTAL DEPTH: 18.5 Feet
SURFACE ELEVATION: 12± Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: SR-167 HOV Lanes

LOCATION: Sta. L 1120+70 80' Left
DATE COMPLETED: Feb. 25, 1993
LOGGED BY: SLT

BORING: B-11

PROJECT NUMBER: 91101-2

PAGE: 1 OF 1

APPENDIX B

LABORATORY TESTING

HONG WEST & ASSOCIATES, INC.

APPENDIX B
LABORATORY TESTING

Representative samples recovered from the borings were returned to the HWA laboratory. Selected soil samples were used for determination of index properties and characterization of engineering parameters. Laboratory tests included moisture content, Atterberg Limits, and one-dimensional consolidation tests.

Moisture Content

The in-situ moisture content of selected soil samples was determined in general accordance with ASTM D 2216-80; test results are indicated on the boring logs in Appendix A.

Atterberg Limits

Atterberg Limits were determined in general accordance with the method outlined in ASTM D 4318-90. The Atterberg Limits include Plastic Limit (PL) and Liquid Limit (LL). The tests were conducted on selected fine-grained soil samples for soil classification, and to aid in estimating soil compressibility and shear strength using empirical correlations. The test results are summarized below.

Boring	Depth (feet)	LL	PL	PI	Classification
B-2	4 - 5.5	41	34	7	ML
B-3	6.5 - 8	33	36	3	ML

One-Dimensional Consolidation

Three Shelby tube samples were selected for one dimensional consolidation tests to determine consolidation characteristics. The tests were conducted in general accordance with ASTM D 2435-90, using fixed-ring consolidometers. The purpose of the consolidation tests was to aid in the estimation of potential consolidation settlement upon placement of additional fill material on alluvial deposits. The test results are shown on the attached figures, and are summarized below:

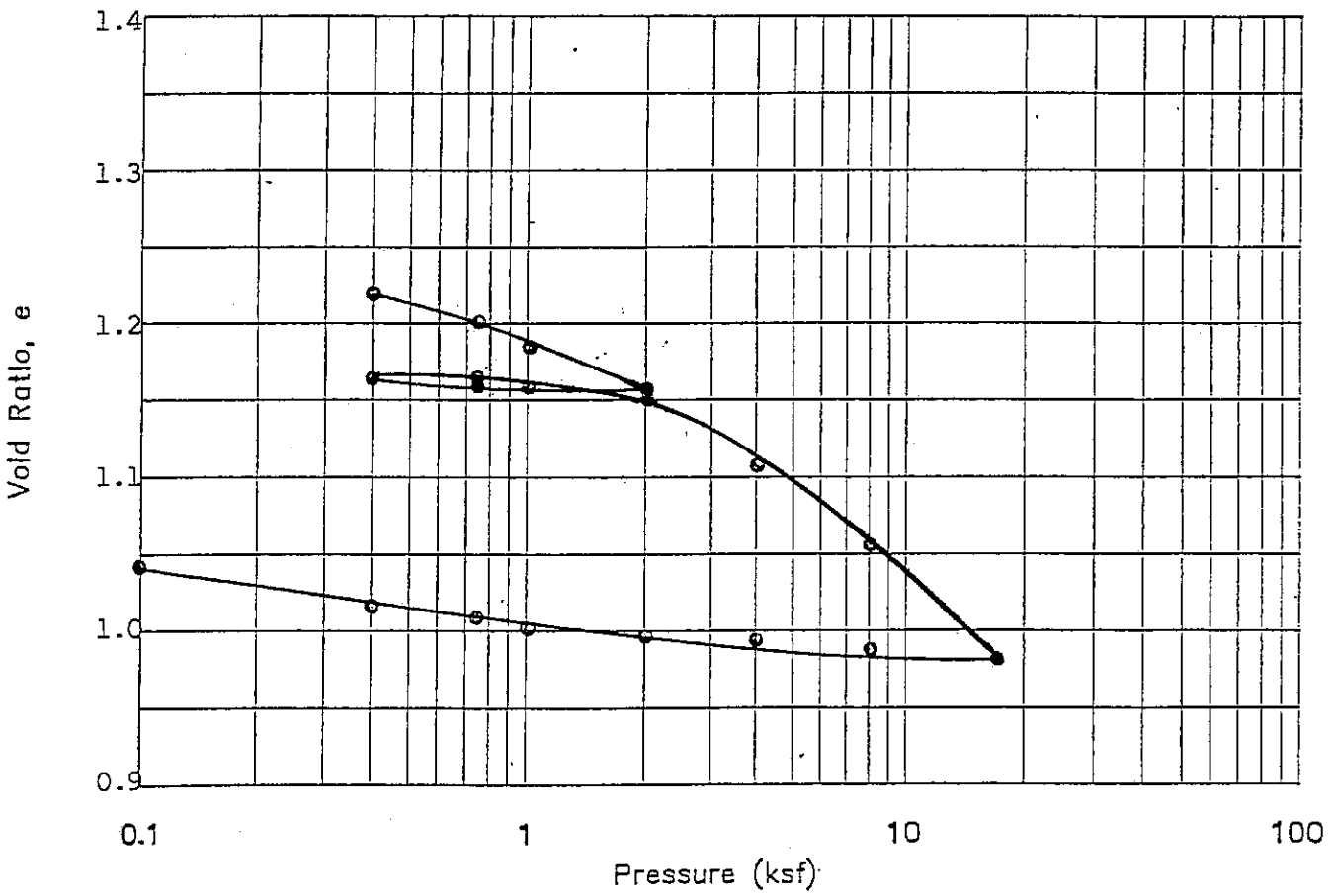
Boring	Depth (feet)	Classifications	Compression Index (Cc)
B-1	6.5 - 8.5	ML	0.22
B-2	6.5 - 8.5	ML	0.24
B-7	5 - 7	Peat	2.54

HONG WEST & ASSOCIATES, INC.

CONSOLIDATION TEST RESULTS

Project: SR-167 HOV Lanes
Location: DR1 Ramp - 84th Ave. South
Sta. DR1 893+70 50' Rt.
Project Number: 91101-2
Date Tested: 2-12-93

Test No. 1
Boring: B-1
Depth (ft.): 6.5-8.5
Diameter (in.): 2.5
Assumed Sp. Gravity: 2.65



	INITIAL	FINAL
Height (in.)	1.0"	.909"
Water Content %	47.2	39.6
Wet Density (pcf)	107.9	112.7
Dry Density (pcf)	73.3	80.7
Saturation %	100	100

Sample Description: Grav SILT with sand (ML)

Liquid Limit: N/A
Plastic Limit: N/A

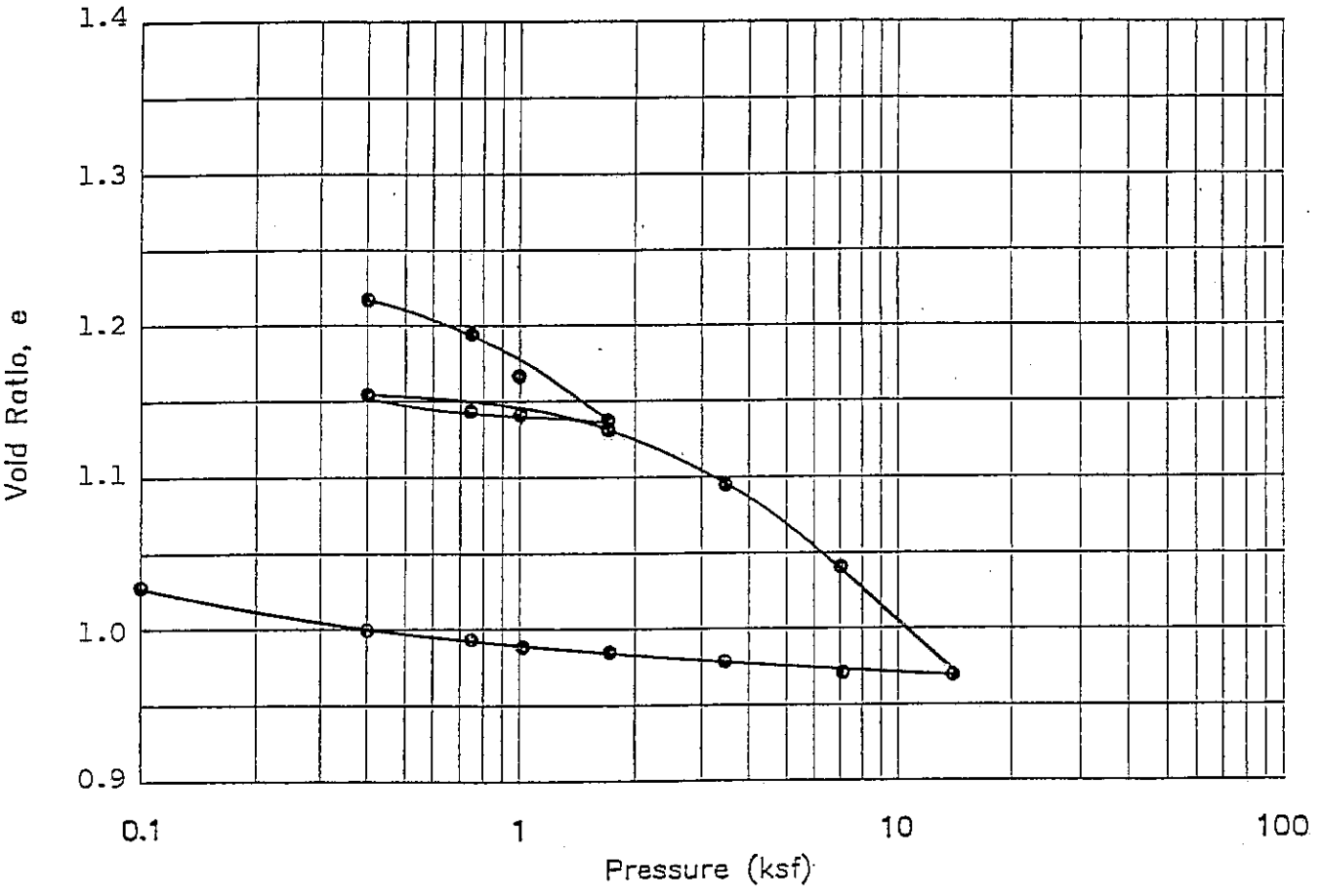
STD-BRD1

HONG WEST & ASSOCIATES, INC.

CONSOLIDATION TEST RESULTS

Project: SR-167 HOV Lanes
Location: DR1 Ramp - 84th Ave. S.
Sta. DR1 896+90 67' Rt.
Project Number: 91101-2
Date Tested: 2-15-93

Test No. 2
Boring: B-2
Depth (ft.): 6.5 - 8.5
Diameter (in.): 2.416
Assumed Sp. Gravity: 2.65



	INITIAL	FINAL
Height (in.)	1.0"	.901"
Water Content %	45.1%	38.5%
Wet Density (pcf)	103.2	109.4
Dry Density (pcf)	71.1	79.0
Saturation %	100	98

Sample Description: Gray SILT with sand (ML)

Liquid Limit: N/A
Plastic Limit: N/A

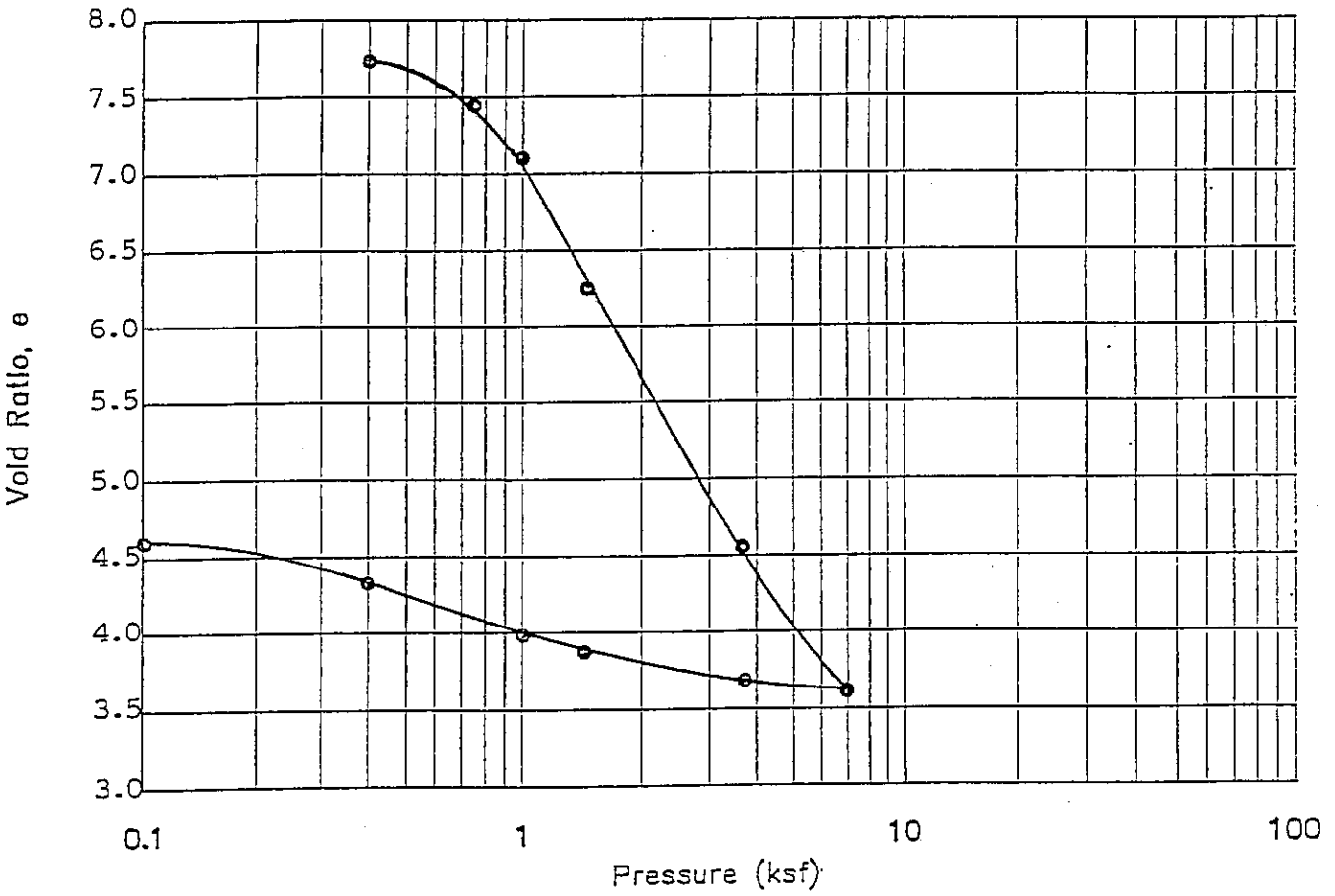
STD-BRD1

HONG WEST & ASSOCIATES, INC.

CONSOLIDATION TEST RESULTS

Project: SR-167 HOV Lanes
Location: Stn L 1004 + 55 CL
Kent, Washington
Project Number: 91101-2
Date Tested: 3-25-93

Test No. 3
Boring: B-7
Depth (ft.): 5 - 7
Diameter (in.): 2.416
Assumed Sp. Gravity: 1.8



	INITIAL	FINAL
Height (in.)	1.0	.627
Water Content %	395%	273%
Wet Density (pcf)	63.9	73.5
Dry Density (pcf)	12.9	19.7
Saturation %	95	100

Sample Description: Dark brown, fibrous PEAT (Pt)

Liquid Limit: N/A
Plastic Limit: N/A

TD-BRD1

APPENDIX C

RESPONSE TO WSDOT COMMENTS

HONG WEST & ASSOCIATES, INC.

APPENDIX C

RESPONSE TO WSDOT REVIEW COMMENTS

WSDOT Comment No. 1

HWA scope of work does not match the scope of work included in the original signed agreement (refer to attached copy). Item number 4 of the original agreement requires that HWA determine the limits of unsuitable material excavation. This was partially completed. On several occasions we specifically identified areas of possible unsuitable material in the So. 180th Interchange area.

Response to WSDOT Comment No. 1

Item no. 4 of the original agreement requires HWA to determine the limits of unsuitable material excavation along the DR2 and AL2 Ramps, S. 180th Street Interchange area. Probings were conducted at DR2 Ramp, between Sta. L 1075 and Sta. L 1082. The results were not presented in HWA's draft report, because detailed geotechnical investigation had been completed in that same area by Shannon and Wilson, for Wall No. 7. In response to the WSDOT comment, the results of HWA's probing are presented on Figure 8 of this report. However, conclusions and recommendations presented by Shannon and Wilson take precedence over the HWA data at the subject location.

The AL2 Ramp is located in an area underlain by outwash sand and glacial till. Since only limited removals (if any) are anticipated in these areas of relatively dense soils, no probing was conducted in this area.

WSDOT Comment No. 2

HWA describes the settlement related to the preload, but neglects to account for the effects of the excavation of the 60 inch diameter pipe. This excavation will occur in identified areas of peat. What are the recommendations to prevent movement of the peat and the potential impacts to the adjacent buildings? Please provide a discussion of options.

Response to WSDOT Comment No. 2

Based on the drawings provided by WSDOT, invert level of the proposed 60-inch pipe will be approximately 2 to 4 feet below the existing ground level, near the toe of the existing embankment. We anticipate that required depths of trench excavation will be on the order of 4 to 6 feet. It is our opinion that use of trench boxes or other conventional shoring systems should be adequate to prevent unacceptably large soil

displacement and potential impacts to adjacent buildings. If excessive seepage into the trench occurs, use of interlocking steel sheetings may be warranted. These steel sheetings (if used) should be installed to a depth sufficient to reduce groundwater seepage into the trenches.

It is our opinion that the contractor should be responsible for selecting and installing an appropriate support system for the trench excavation. The selected support system should be relatively rigid to prevent excessive movements of the retained soils, and should allow successful control of groundwater seepage in the trenches.

WSDOT Comment No. 3

As you know the culvert crossing at STA. L 909+00 has been eliminated. However, explorations discovered the occurrence of water and silty sand in this area. What is the potential for settlement of the roadway fill in this area?

Response to WSDOT Comment No. 3

Borings B-8 and B-9 drilled near Sta. L 909+00 intercepted embankment fill material over saturated silty sand. Results of previous and the present geotechnical investigations indicate saturated silty sands are common along the SR-167 alignment. Compared to soft silt and clay that are also common along the SR-167 alignment, silty sand is relatively incompressible, and does not exhibit significant long term consolidation. With the 2 to 3 feet of additional fill material, the potential for settlement of the roadway fill in this area does not appear significant.

WSDOT Comment No. 4

Investigation of the location of the twin 48 inch culverts at Sta. L 1120+70 determined that these pipes will be bored through a layer of peat that is 5 to 8 feet thick. Settlement after completion of the crossing has not been addressed. Could a better location be found by exploration that would have less underlying peat and less potential for settlement of both the new structures as well as the existing roadway?

Response to WSDOT Comment No. 4

Settlement of the roadway after construction of the culvert crossing depends on the disturbance of soils around the culverts. It is the contractor's responsibility to select and implement appropriate boring techniques and equipment to minimize soil disturbance.

A better location for the crossing could probably be found, but this would require more detailed hydrologic and geotechnical studies. HWA is available to develop a scope for this, should you require.

WSDOT Comment No. 5

HWA identifies areas of peat in the median and discusses overexcavation specifically for the median barrier. However, excavation and trenching will be required for drainage and electrical conduits in these same areas. What impacts will this excavation have on the new barrier and the existing roadway? Is overexcavation required for this work also?

Response to WSDOT Comment No. 5

Drainage and electrical conduits were not included in the HWA authorized scope of services. Please refer to Section 3.3.2 of this report, where we recommend a minimum of 12 inches of granular fill beneath the bottom of median wall footings. Trenches excavated deeper than this may encounter peat, organic soils, or previously placed fill. The approximate extrapolated extents of subsurface materials are shown on Figures 16 and 17.